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Arizona Climate Change Advisory Group

Completed and Pending Policy Option Descriptions

June 22, 2006 CCAG Meeting

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Table 1.

Energy Supply Technical Work Group

Summary List of Completed and Pending Policy Options

#	Policy Name	GHG Savings (MMtCO_2e)	Cost Effectiveness (\$/tCO_2e)	
ES-1	Environmental Portfolio Standard / Renewable Energy Standard and Tariff	1a(1) 2010: 1.39 2020: 8.0 1c 2010: 4.19 2020: 16.4	\$8 \$6	Pending
ES-2	Public Benefit Charge Funds *(1 mill/kWh for Distributed Renewable Gen.)*	2010: 1.46 2020: 4.1	\$280	Pending
ES-3	Direct Renewable Energy Support (including Tax Credits and Incentives, R&D, and siting/zoning)	(analyzed as RCI-7) 2010: 0.1 2020: 2.1	(analyzed as RCI-7) \$31	Completed
ES-4	GHG Cap and Trade	(1) 2010: -0.28 2020: 4.4 (2) 2010: 0.17 2020: 2.0 (3) 2010: -0.2 2020: 16.5 (4) 2010: 0.18 2020: 18.5	\$7 \$10 \$17 \$19	Completed
ES-5	Generation Performance Standards	2010: 5.63 2020: 10.2	\$29	Pending
ES-6	Carbon Intensity Targets	2010: 0.0 2020: 14.0	\$44	Pending
ES-8	CO2 Tax *(at \$5)* CO2 Tax *(at \$15)*	2010: 0.53 2020: 2.4 2010: 0.06 2020: 5.4	\$3 -\$2	Pending
ES-9	Reduce Barriers to Renewables and Clean DG	(analyzed as RCI-6) 2010: 0.4 2020: 2.7	(analyzed as RCI-6) -\$25	Completed

ES-10	Metering Strategies	ES-10 is an enabling policy quantified under RCI-6 and RCI-7.		Completed
ES-11	Pricing Strategies	(analyzed as RCI-8)	(analyzed as RCI-8)	Completed
ES-12	Integrated Resource Planning	2010: 0.06 2020: 5.4	-$2	Completed

ES-1 Environmental Portfolio Standard / Renewable Energy Standard and Tariff (REST)

Policy Description:

An environmental portfolio standard (EPS) is a requirement that utilities must supply a certain percentage of electricity from environmentally friendly sources. An EPS differs from a Renewable Portfolio Standard (RPS) in that an EPS can include more options than renewables for meeting the requirement. Utilities can meet their requirements by purchasing or generating environmentally friendly electricity or by purchasing clean energy credits. By giving utilities the flexibility to purchase clean energy credits, a market in these credits will emerge that will provide an incentive to companies that are best able to generate clean energy, either through energy efficiency or renewables. Other options for meeting the requirement are possible depending on how the EPS is structured. For example, a provision can be included so that funding for research and development is applied toward meeting a utility's commitment.

Policy Designs:

The TWG analyzed five policy designs:

ES-1a(0): The likely changes by the Arizona Corporations Commission (ACC) to the EPS applied only to ACC-jurisdictional utilities: 5% in 2015, 15% in 2025; Starting in 2007, 5% of the total renewable requirement must be from distributed renewables, increasing to 30% by 2011 and remaining at 30% in future years. Renewable Energy Credit (REC) trading is allowed, provided that all other associated attributes are retired when applying RECs to the Annual Renewable Energy Requirement; out-of-state resources can be used provided that the necessary transmission rights are obtained and utilized.

ES-1a(1): **The ACC's likely changes to the EPS, with SRP continuing with its proposed renewable investments**. The SRP has set a target to generate 15% of its electricity from renewable resources by 2025.

ES-1a(2): The ACC's likely changes to the EPS extended statewide.

ES-1b: Alternative scenario for ACC jurisdictional utilities: 1% in 2005, increasing 1% each year to 26% in 2025. Allow out-of-state renewables and REC trading.

ES-1c: Alternative scenario extended statewide.

- **Goal levels:** As noted above.
- **Timing:** As noted above.

- **Parties:** Utilities as noted above.
- **Other:** Apply a least-cost approach, reflecting resource availability constraints, to determine which renewable energy resources and technologies would be used to meet the EPS beyond the specific requirements laid out in the proposals.

Implementation Method(s):

An EPS is usually implemented through a regulatory requirement (mandate) on the applicable utilities.

Related Policies/Programs in Place:

In the existing EPS, utilities (not including SRP) must generate a specified percentage of their total retail sales from renewable energy:

- Started in 2001 at 0.2% and increased annually to 1% in 2005 and will increase to 1.1% in 2007. Expires in 2012.
- 2001–2003: 50% of current EPS requirement must be solar electric; remainder can be other environmentally friendly technologies including no more than 10% R&D.
- 2004–2012: 60% of resources must be solar electric.
- Environmental Portfolio Surcharge of $0.000875 per kWh with caps by customer class.

Type(s) of GHG Benefit(s):

- CO2: By creating a substantial market in renewable generation, an EPS can reduce fossil fuel use in power generation, and correspondingly reducing CO2 emissions
- Black Carbon: To the extent that generation from coal and oil is displaced by renewables, black carbon emissions will decrease.

Estimated GHG Savings and Costs per MTCO2e:

#	Policy	Scenario	Reductions (MMTCO2e)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO2
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-1	RE/Std/Tariff, ES-1a(0)	ACC Proposal alone	0.80	4.4	26	331	13

ES-1	RE/Std/Tariff, ES-1a(1)	ACC Proposal + SRP program	1.39	8.0	47	366	8
ES-1	RE/Std/Tariff, ES-1a(2)	ACC Proposal Statewide	1.42	7.7	46	538	12
ES-1	RE/Std/Tariff, ES-1b	Alternative Proposal for ACC Utilities	2.31	9.2	65	281	4
ES-1	RE/Std/Tariff, ES-1c	Alternative Proposal Statewide	4.19	16.4	116	752	6

Data Sources, Methods and Assumptions:

- **Data Sources:** CDEAC, WECC, EIA, EPA, Arizona Solar Energy Center, "*Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*" by Sargent & Lundy.
- **Quantification Methods:** A simple capacity expansion model was developed in Excel specifically for this policy option. A trajectory of MWhs needed to satisfy the REST requirement was calculated, both for central renewable generation and distributed renewables. Renewable and fossil technologies were characterized in terms of cost and operating profiles, and available resources in the state were also defined. Technologies include three classes of wind, concentrating solar power, geothermal, biomass, landfill gas, distributed solar PV, distributed solar thermal, conventional coal, integrated gasification combined cycle with carbon capture and storage (IGCC with CCS), natural gas combined cycle (NGCC), and natural gas combustion turbines (NGCT). We assumed that 75% of the Renewable Energy Standard and Tariff (REST) requirement would be met through REC trading. We also assumed that corresponding CO2 reductions would be bundled with the RECs and count toward the emission reduction performance of this policy. We assumed a $5 per MWh REC price, which is consistent with available low-cost wind and other renewable resources in the West and is consistent with REC price assumptions in Integrated Resource Plans by various western utilities as reported in *Balancing Cost and Risk: The Treatment of Renewable Energy in Western Utility Resource Plans* (August 2005, Lawrence Berkeley National Laboratory). The model found the least-cost mix of renewables, constrained by available resources, to satisfy 25% of the central renewable requirement. An assumption that the distributed renewable requirement will be met by 50% solar PV and 50% solar thermal was made. Each renewable was also defined by the share of generation it displaces from NGCT, NGCC, and coal. The model then determines how many MWhs of NGCT, NGCC and coal would be displaced and the

corresponding CO2 emissions. The model also tracks the cost of generation for renewables and the displaced fossil; the present value of the difference is reported above.

- **Key Assumptions:** Cost and performance characteristics of generating technologies; resource availability; no demand response as a result of policy; no transmission and distribution modeled.

Key Uncertainties:

As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are, first, related directly to the key assumptions listed above. If those assumptions are incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- Reductions in overall energy consumption and the shift from fossil fuel generation as a result of an EPS will lead to reductions in criteria air pollutants and, consequently, lower health impacts and costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- While much of the EPS requirement will come from low-cost renewables such as wind and biomass, meeting the requirement may lead to a moderate increase in direct costs to utilities implementing the EPS policy and a small increase in overall electricity system cost for Arizona. At the same time, investment in new technologies resulting from the EPS may spur economic development and corresponding job growth, and to the extent the renewable energy is derived from Arizona-based capital projects, generate additional local tax revenues.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

ES-2 Public Benefit Charge Funds

Policy Description:

A public benefit fund (PBF) is a state fund dedicated to support energy efficiency (EE) and renewable energy (RE), funded through a per kiloWatthour charge on electricity sales. To date, nineteen states have implemented PBF programs. A small charge rate, typically in the 2 to 5 mils per kWh range, is applied to electricity sales in the state and collected by a PBF manager. Funds are typically used to support EE and RE in a number of ways, such as through public education, R&D, demonstration projects, direct grants/buy-downs/tax credits to subsidize advanced technologies, and low interest revolving loans. Funding goes to the residential, commercial and industrial sectors. Fund managers decide which technologies to support based on criteria such as GHG reduction potential, cost-effectiveness, co-benefits, etc.

Policy Design:

Introduce a 4 mills ($0.004) per kWh charge to be applied as determined by an authorized entity, probably the ACC. For the purposes of analysis, we assume that 1 mill per kWh is available for distributed renewable generation; the remaining portion of the fund is applied to energy efficiency projects and is quantified by the RCI TWG. We assume that 50% of renewable funding supports solar photovoltaics and 50% supports solar thermal technologies. The total sum raised would be approximately $100-145 million per year for distributed renewables.

- **Goal levels:** As noted above.
- **Timing:** ASAP.
- **Parties:** Public Benefit Fund Manager created by legislature. Utilities will collect the charges from customers and transfer to the Fund Manager. Fund Manager will distribute money to be implemented at the residential, commercial and industrial levels.

Implementation Method(s):

- Funding mechanisms and or incentives
- Pilots and demos
- Research and development
- Education

Related Policies/Programs in Place:

There is no PBF in place in Arizona.

Type(s) of GHG Benefit(s):

- CO2: By spurring investment in energy efficient technologies and small-scale renewable generators, PBF programs reduce the need for generation from fossil fuel plants, which can lead to a significant reduction in GHG emissions.
- Black Carbon: To the extent that generation from coal and oil is displaced by energy efficiency and renewables, black carbon emissions will decrease.

Estimated GHG Savings and Costs per MTCO2e:

#	Policy	Scenario	Reductions (MMTCO2e)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO2
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-2	Public Benefits Fund	(Distributed Renewables only)	1.46	4.1	34	9383	280

Data Sources, Methods and Assumptions:

- **Data Sources:** CDEAC, WECC, EIA, EPA, Arizona Solar Energy Center, "*Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*" by Sargent & Lundy.
- **Quantification Methods:** A simple capacity expansion model was developed in Excel specifically for this policy option. This policy was partly analyzed by the RCI TWG. We assumed that 1 mil per kwh of the 4 mils charge in this policy would be devoted to distributed renewable generation. The 1 mil per kwh charge was applied to the reference case forecast of electricity generation to determine the total annual funding available. We assumed that half of the funding would go toward PV and half toward solar thermal. The funding would cover the difference between the cost of distributed renewables and the retail cost of electricity, reflecting the incremental funding needed to achieve the investment. Renewable and fossil technologies were characterized in terms of cost and operating profiles, and available resources in the state were also defined. The model calculated the PV and solar thermal generation resulting from the PBF funding. Each distributed renewable was also defined by the share of generation it displaces

from NGCT, NGCC, and coal. The model then determined how many MWhs of NGCT, NGCC and coal would be displaced and the corresponding CO2 emission reductions. The model also tracks the cost of generation for renewables and the displaced fossil; the present value of the difference is reported above.

- **Key Assumptions:** Cost and performance characteristics of generating technologies now and in the future; resource availability; no demand response as a result of policy; no transmission and distribution modeled.

Key Uncertainties:

- As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are, first, related directly to the key assumptions listed above. If those assumptions were incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- Reductions in overall energy consumption and the shift from fossil fuel generation as a result of a PBF will lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- Much of the investment made by the PBF will go into zero- or low-cost (even negative-cost) energy efficiency and small-scale renewables, and the PBF program can more than pay for itself through cost-effective investments. Nevertheless, the impact on the larger electricity system of the PBF program can lead to a small increase in overall electricity system cost. At the same time, though, investment in new technologies resulting from the PBF could spur economic development in Arizona.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

ES-3 Direct Renewable Energy Support (including Tax Credits and Incentives, R&D, and siting/zoning)

Policy Description:

The purpose of this suite of policies is to encourage investment in renewables by providing direct financial incentives and by removing siting and zoning barriers to renewable energy facilities. Funding R&D also encourages development of new renewable technologies.

Direct renewable energy support can take many forms including: (1) direct subsidies for purchasing/selling renewable technologies given to the buyer/seller; (2) tax credits or exemptions for purchasing/selling renewable technologies given to the buyer/seller; (3) tax credits or exemptions for operating renewable energy facilities; (4) feed-in tariff, which is a direct payment to renewable generators for each kWh of electricity generated from a qualifying renewable facility; and (5) tax credits for each kWh generated from a qualifying renewable facility.

R&D funding can be targeted toward a particular technology or group of technologies as part of a state program to build an industry around that technology and/or to set the stage for adoption of the technology in the state. R&D funding can also be made available to any renewable or other advanced technology through an open bidding procedure (i.e., driven by bids received rather than by an effort to develop a particular technology). Funding can also be provided for demonstration projects to help commercialize technologies that have already been developed but are not yet in widespread use.

Many renewable energy technologies – particularly wind power – face siting and zoning obstacles. Often the best wind resources are in scenic areas, which can spur opposition to development. Further, they may not be near existing transmission lines. Policies can be developed to help overcome these barriers.

Policy Design:

Analyzed as RCI-7, Distributed Generation/Renewable Energy Applications.

- **Goal levels:** As noted above.
- **Timing:** As noted above.
- **Parties:** A state agency would administer the direct subsidies, and individuals, commercial enterprises, industrial enterprises would receive them. Utilities would administer the feed-in tariff under supervision of a state agency, and independent power producers operating qualifying renewable facilities would

receive the payments. A state agency would administer R&D funding through a public-private partnership with companies and research institutions. Note that a source of funds to cover subsidies or other support would have to be determined.

Implementation Method(s):

- Funding mechanisms and or incentives
- Pilots and demos
- Research and development

Related Policies/Programs in Place:

- Personal income tax credit for renewables amounting to 25% of the cost of installation with a maximum of $1,000.
- Sales tax exemption for up to $5,000 of the cost of a renewable installation.

Type(s) of GHG Benefit(s):

- CO2: By providing a financial incentive for renewable generation and helping overcome siting and zoning barriers facing renewables, more renewable facilities will be installed and more electricity from renewables will be generated. This zero carbon generation will displace generation from fossil fuels and lower carbon emissions. By funding R&D, new or improved renewable technologies will be developed or commercialized, leading to even more installation of renewables and resulting reduction in carbon emissions in the long term.
- Black Carbon: To the extent that generation from coal and oil is displaced by renewables, black carbon emissions will decrease.

Estimated GHG Savings and Costs per MTCO2e:

- This option is quantified under RCI-7, Distributed Generation/Renewable Energy Applications

Data Sources, Methods and Assumptions:

- See RCI-7, Distributed Generation/Renewable Energy Applications

Key Uncertainties:

- See RCI-7, Distributed Generation/Renewable Energy Applications

Ancillary Benefits and Costs:

- Reductions in overall electricity consumption and the shift from fossil fuel generation as a result of new renewables will lead to reductions in criteria air pollutants and, consequently, health costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- Renewable resources may be less risky than fossil resources because they are not subject to unexpected changes in the price of fossil fuels.

- The operating costs of renewable generation, primarily maintenance, are spent locally and are a direct boost to local and state economies, whereas the primary cost of operating fossil fuel plants – fossil fuels – may go out of state and not contribute to the local or state economy.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

ES-4 GHG Cap and Trade Program

Policy Description:

A cap and trade system is a market mechanism in which CO2 emissions are limited or capped at a specified level, and those participating in the system can trade permits (a permit is an allowance to emit one ton of CO2) in order to lower costs of compliance. For every ton of CO2 released, an emitter must hold a permit. Therefore, the number of permits issued or allocated is, in effect, the cap. The government can give permits away for free (according to any one of many different criteria to those participating in the cap & trade system or even to those who are not), auction them, or a combination of the two. Participants can range from a small group within a single sector to the entire economy and can be implemented upstream (at the level of fuel extraction or import) or downstream at the points where fuel is consumed.

Policy Design:

The TWG's principal interest is an economy-wide GHG cap and trade program implemented on a regional (multi-state) or preferably a national basis. The TWG will look at existing studies of such programs to infer what the impact on Arizona may be. The TWG will also conduct comparative analyses concerning the costs of reaching a given cap on a national and a regional basis. It may be possible to explore these two options for both an economy-wide and a power-sector-only program.

Initially, there was some interest in exploring a cap-only program for the state, but implementation of such an approach would effectively echo other policy options being considered, such as an EPS/REST (ES-1) or a GPS (ES-5). .

Other issues to consider:

- Applicability (sources & sectors included)
- Gases included
- Permit allocation rules (method; options for new market entrants)
- Generation-based or load-based; leakage concerns
- Linkage to other trading systems
- Banking and borrowing; early reduction credit
- Inclusion of emission offsets (within or outside sector, geography)

- Incentive opportunities (e.g., interaction with other pollution regulations like Pennsylvania's EDGE program).

For illustration of the potential impact of various levels of a national cap and trade program, we analyzed four national cap and trade scenarios published in March 2006 by the US Energy Information Administration. These scenarios are defined below under Goal Levels. The GHG reductions and cost results presented below are regional results that have been scaled to approximate what would occur in Arizona.

- **Goal levels:**

Case Name	GHG Intensity Reduction Goal (percent per year)		Safety-valve Price (2004 dollars per metric ton CO_2 equivalent)		Other
	2010-2019	2020-2030	2010	2030	
Cap-Trade 1	2.4	2.8	$ 6.16	$ 9.86	Greenhouse gas cap-and-trade system with safety-valve.
Cap-Trade 2	2.6	3.0	$ 8.83	$14.13	
Cap-Trade 3	2.8	3.5	$22.09	$35.34	
Cap-Trade 4	3.0	4.0	$30.92	$49.47	

- **Timing:** As noted above.
- **Parties:**

Implementation Method(s):

- Market-based mechanisms with underlying regulatory obligation.
- Arizona cannot implement a regional or national cap and trade program on its own, of course, but it can work with other jurisdictions and federal officials toward this outcome.

Related Policies/Programs in Place:

- No cap & trade system is in place in Arizona.

Type(s) of GHG Benefit(s):

- CO2: A cap & trade system is a direct limit on CO2 emissions. The level of the cap determines reductions.
- Black Carbon: To the extent that generation from coal and oil declines under a cap and trade system, black carbon emissions will also decrease.

Estimated GHG Savings and Costs per MTCO2e:

			Reductions (MMTCO2e)		

#	Policy	Scenario	2010	2020	Cumulative Reductions (2006 - 2020)	NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO2
ES-4	Cap & Trade 1	2.4% - 2.8% CI, $6.16 - $9.86 safety valve	-0.28	4.4	7	51	7
ES-4	Cap & Trade 2	2.6% - 3.0% CI, $8.83 - $14.13 safety valve	0.17	2.0	9	85	10
ES-4	Cap & Trade 3	2.8% - 3.5% CI, $22.09 - $35.34 safety valve	-0.20	16.5	63	1096	17
ES-4	Cap & Trade 4	3.0% - 4.0% CI, $30.92 - $49.47 safety valve	0.18	18.5	88	1630	19

Data Sources, Methods and Assumptions:

- **Data Sources:** Data for the electricity modeling done in this analysis comes from the US Energy Information Administration (EIA) and can be found within the National Energy Modeling System (NEMS). Data in NEMS includes representation of the existing generation, transmission and distribution system down to the unit level. NEMS also includes data that characterizes new plants that the model can choose to build to meet projected demand growth. EIA publishes Assumptions to the Annual Energy Outlook that details key assumptions in the current version of the model. EIA also publishes NEMS model documentation.
- **Quantification Methods:** The modeling presented here was done by the Energy Information Administration in a Congressional Service Report from March 2006 entitled "*Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals*." The scenarios are listed above and are for national cap and trade policies. We scaled the impacts to approximate results in Arizona for the four scenarios presented here in the same way that we analyzed the NEMS modeling done specifically for this process. For the cap and trade scenarios, we approximated the cost of the policies by multiplying CO2 reductions by one-half of the market price for CO2 allowances. (The allowance price is the marginal price of allowances needed to produce the reported emission reductions; the actual cost of each ton of reductions ranges from zero up to the price of allowances. For simplicity, we assume that the actual cost is an average of the

high (market clearing price) and low (zero) cost of reductions, which equals one-half of the market clearing price). We report costs as a net present value of the stream of costs from 2006 – 2020. We found the number of tons reduced by taking the difference between the emissions in the policy case and a reference case NEMS run. Because the NEMS model is a national model with multi-state regions (Arizona is within the Rocky Mountain Power Area), the results for Arizona were derived from results in the region. We shared out the regional emission and cost results according to the share of Arizona generation within the region.

- **Key Assumptions:** Any analysis of state-level policies using the National Energy Modeling System (NEMS) from the US Energy Information Administration should be weighed carefully. NEMS is a national model that consists of 13 regions. State policies cannot be implemented explicitly within NEMS, and the state-specific impacts cannot be known explicitly. We must make assumptions about the impact of policies at the state level by sharing out regional results. In reality, the state-level changes resulting from policy may differ substantially from the changes in the region.

Key Uncertainties:

As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are related directly to the key assumptions and quantification methods listed above. If those assumptions were incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- The shift from fossil fuel generation as a result of a cap and trade system will lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.
- Water use may be reduced through renewable versus combustion technologies.
- Allowing “offsets” from outside the capped sector can create the incentive to quantify and reduce GHG emissions from sources in other sectors.
- The shift in fossil fuel resources as a result of a cap and trade system could have unintended consequences, including increased cost of natural gas and need for additional natural gas infrastructure.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

The CCAG noted the preference for cap and trade programs to be approached at a national level and to cover the widest spectrum of economic sectors possible.

ES-5 Generation Performance Standards

Policy Description:

A generation performance standard (GPS) is typically a requirement that electricity utilities or load serving entities (LSE) sell electricity with an average emission rate below a specified mandatory standard. Utilities must take action to ensure that their generation mix meets the standard.

A variation of a GPS is to incorporate the standard within a cap and trade system in which permits are allocated by dividing the total cap by the total number of MWhs generated to arrive at the performance standard. Permits are then given to each participant based on its own generation multiplied by the performance standard. Generators with emission rates lower than the GPS would receive more allowances than they need. Generators with emission rates higher than the GPS would receive fewer allowances than needed. As electricity generation increases, everything else being equal, the number of permits per MWh would decline because of the cap.

A third variation of a GPS is to establish the standard and allocate allowances based on that standard every year. In this variation, as electricity generation increases, plants would receive more permits. Utilities could trade permits in order to achieve the standard, but there would be no fixed cap on emissions. This variation provides a financial incentive (via trading) for generators to reduce emissions so that they can sell unneeded permits to generators who have high emissions.

Policy Design:

Apply a GPS only to new generation. As new capacity comes on-line, those plants would receive an allocation based on the GPS standard. Utilities could trade permits in order to achieve the standard, but there would be no fixed cap on emissions. The GPS level would be equivalent to a new natural gas combined cycle plant. Assessment of this option should consider that new electricity demand in Arizona might be served, at least in part, by out-of-state resources. Accordingly, analysis of this option should consider how a GPS policy might affect decisions to build new capacity inside or outside of Arizona.

- **Goal levels:** Set a GPS equivalent to a new natural gas combined cycle plant applicable to new supply, whether generated in Arizona or imported.
- **Timing:** As new generation capacity is built or power is imported.
- **Parties:** Utilities (electricity generators).

Implementation Method(s):

- Market based mechanisms with underlying regulatory obligation.

Related Policies/Programs in Place:

- No GPS system is in place in Arizona.

Type(s) of GHG Benefit(s):

- CO2: A GPS program is a direct limit on CO2 emissions. The level of the standard determines reductions.
- Black Carbon: To the extent that generation from coal and oil declines under a GPS program, black carbon emissions will also decrease.

Estimated GHG Savings and Costs per MTCO2e:

#	Policy	Scenario	Reductions (MMTCO2e)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO2
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-5	Generation Performance Standard	All new supply (generated or imported) as clean as NGOC	5.63	10.2	104	2980	29

Data Sources, Methods and Assumptions:

- **Data Sources:** CDEAC, WECC, EIA, EPA, Arizona Solar Energy Center, "*Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*" by Sergeant & Lundy.
- **Quantification Methods:** A simple capacity expansion model was developed in Excel specifically for this policy option. Renewable and fossil technologies were characterized in terms of cost and operating profiles, and available resources in the state were also defined. Technologies include three classes of wind, concentrating solar power, geothermal, biomass, landfill gas, conventional coal, integrated gasification combined cycle with carbon capture and storage (IGCC with CCS), natural gas combined cycle (NGOC), and natural gas combustion turbines (NGOC). The reference case forecast of electricity generation was the starting point for this analysis. We assumed that existing resources would continue to operate in the state over the analysis period. We subtracted generation from existing resources from the reference forecast of total generation to find a new generation forecast. The model then found the least-cost mix of new

generation needed, subject to the constraint that all new generation must have an equal or lower emission rate than new natural gas combined cycle plants. The model tracks cost and CO_2 emissions associated with new generation. We also ran the model without constraints to develop a reference case. We then calculate the difference in CO_2 emissions and total cost of generation between the policy case and the reference case. Those results are reported above.

- **Key Assumptions:** Cost and performance characteristics of generating technologies now and in the future; resource availability; no demand response as a result of policy; any transmission and distribution modeled.

Key Uncertainties:

As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are, first, related directly to the key assumptions listed above. If those assumptions were incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- The shift from fossil fuel generation as a result of a GPS system will lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending.

Level of Group Support:

TBD

Barriers to Consensus:

TBD

ES-6 Carbon Intensity Targets

Policy Description:

Rather than a fixed cap on carbon emissions, a carbon intensity target is a limit on the ratio of carbon emissions to a measure of output. Absolute emissions can increase as output increases. Measures of output are clear for some sectors like electricity generation (e.g., MWh), but can difficult for other sectors (e.g., manufacturing). One measure of output for other sectors could be dollars equal to the value of the output.

Policy Design:

Arizona implements a mandatory carbon intensity target that begins in 2010 (equal to carbon intensity in 2010) and that declines by 3% annually through 2025. The carbon intensity target is translated annually into a cap, and trading is allowed under that cap.

- **Goal levels:** As noted above.
- **Timing:** As noted above.
- **Parties:** Utilities and electric generators.

Implementation Method(s):

- Market based mechanisms with underlying regulatory obligation.

Related Policies/Programs in Place:

- No carbon intensity target is in place in Arizona.

Type(s) of GHG Benefit(s):

- CO2: A carbon intensity target may or may not reduce CO2 emissions. A stringent intensity target is more likely to lead to reductions than a lenient target. A less stringent target may curb growth in emissions, but not reduce absolute emissions.
- Black Carbon: To the extent that generation from coal and oil declines under a carbon intensity target, black carbon emissions will also decrease.

Estimated GHG Savings and Costs per MTCO2e:

			Reductions (MMTCO2e)		

#	Policy	Scenario	2010	2020	Cumulative Reductions (2006 - 2020)	NPV (2006–2020) $ Millions	Cost-Effective-ness $/tCO2
ES-6	Carbon Intensity Target	Intensity improvement of 3%/year 2010-2025	0.00	14.0	70	3119	44

Data Sources, Methods and Assumptions:

- **Data Sources:** CDEAC, WECC, EIA, EPA, Arizona Solar Energy Center, "*Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*" by Sergeant & Lundy.
- **Quantification Methods:** A simple capacity expansion model was developed in Excel specifically for this policy option. Renewable and fossil technologies were characterized in terms of cost and operating profiles, and available resources in the state were also defined. Technologies include three classes of wind, concentrating solar power, geothermal, biomass, landfill gas, conventional coal, integrated gasification combined cycle with carbon capture and storage (IGCC with CCS), natural gas combined cycle (NGCC), and natural gas combustion turbines (NGCT). The reference case forecast of electricity generation was the starting point for this analysis. We assumed that existing resources would continue to operate in the state over the analysis period. We subtracted generation from existing resources from the reference forecast of total generation to find a new generation forecast. The model then found the least-cost mix of new generation needed, subject to the constraint that CO2 emissions not exceed the limit imposed by the carbon intensity target. The model tracks cost and CO2 emissions associated with new generation. We also ran the model without constraints to develop a reference case. We then calculate the difference in CO2 emissions and total cost of generation between the policy case and the reference case. Those results are reported above.
- **Key Assumptions:** Cost and performance characteristics of generating technologies now and in the future; resource availability; no demand response as a result of policy; no transmission and distribution modeled.

Key Uncertainties:

- As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are, first, related directly to the key assumptions listed above. If those assumptions were incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- The shift from fossil fuel generation as a result of a carbon intensity target will lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

ES-8 CO_2 Tax

Policy Description:

A CO_2 tax is a tax on every ton of CO_2 emitted. Companies would either pass the cost on to consumers, change production to lower emissions, or a combination of the two. Either way, consumers would see the implicit cost of CO_2 emissions in products and services and would adjust behavior to purchase substitute goods and services that result in lower CO_2 emissions. Typically, a CO_2 tax is put in place with an income tax reduction to offset the economic impact of the new tax. CO_2 tax revenue could go completely to income tax reductions or part of it could go toward policies and programs to assist with CO_2 reductions.

Policy Design:

Adopt a flat $5 per ton economy-wide, upstream CO_2 tax, analyzing this tax as if adopted on a national basis and evaluating the resulting impact on Arizona. Other levels (such as $10/ton and $15/ton) may be assessed if resources permit so as to consider elasticity in costs and GHG reductions. Some members of the CCAG expressed concern about moving forward with analyzing this option.

- **Goal levels:** As noted above.
- **Timing:** Not considered.
- **Parties:** All (economy-wide).

Implementation Method(s):

- Market-based (economic) mechanism with underlying legal obligation.

Related Policies/Programs in Place:

- No CO_2 tax is in place in Arizona.

Type(s) of GHG Benefit(s):

- CO_2: A CO_2 tax is a disincentive to emit CO_2 emissions. Producers and consumers will adjust behavior to avoid the tax and thereby reduce CO_2 emissions in the process.
- Black Carbon: To the extent that generation from coal and oil declines under a CO_2 tax, black carbon emissions will also decrease.

Estimated GHG Savings and Costs per MTCO2e:

#	Policy	Scenario	Reductions (MMTCO2e)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO2
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-8	CO2 Tax	$5/ton upstream tax, results are for electricity only	0.53	2.4	11	30	3
ES-8	CO2 Tax	$15/ton upstream tax, results are for electricity only	0.06	5.4	28	-70	-2

Data Sources, Methods and Assumptions:

- **Data Sources:** Data for the electricity modeling done in this analysis comes from the US Energy Information Administration (EIA) and can be found within the National Energy Modeling System (NEMS). Data in NEMS includes representation of the existing generation, transmission and distribution system down to the unit level. NEMS also includes data that characterizes new plants that the model can choose to build to meet projected demand growth. EIA publishes Assumptions to the Annual Energy Outlook that details key assumptions in the current version of the model. EIA also publishes NEMS model documentation.
- **Quantification Methods:** We applied a tax of $5 per ton CO2 to electricity generators at the national level. CO2 reductions were found by comparing emissions from the policy case to emissions from a reference case. Costs were estimated by comparing policy and reference case new generating capacity investments, operating and maintenance costs for all generation, fuel costs for all generation, and transmission and distribution costs for all generation. The reported cost for the policy is the net present value of the difference in the above costs between the policy and reference cases. Because the NEMS model captures the CO2 tax in the price of fuel, we simply substituted the reference case price of fuel for the policy case price of fuel, which reflects the CO2 tax. In treating CO2 tax revenues in this way, we implicitly assumed that the revenues would be recycled back to Arizona. However, we did not distinguish how the revenue would be recycled, nor did we capture any macroeconomic effects of recycling. The costs reported are the direct social cost of the policy (not accounting for macroeconomic impacts), not the cost to utilities and ratepayers, which depends

on whether and how revenues are recycled. Because the NEMS model is a national model with multi-state regions (Arizona is within the Rocky Mountain Power Area), the results for Arizona were derived from results in the region. We shared out the regional emission and cost results according to the share of Arizona generation within the region.

- **Key Assumptions:** Any analysis of state-level policies using the National Energy Modeling System (NEMS) from the US Energy Information Administration should be weighed carefully. NEMS is a national model that consists of 13 regions. State policies cannot be implemented explicitly within NEMS, and the state-specific impacts cannot be known explicitly. We must make assumptions about the impact of policies at the state level by sharing out regional results. In reality, the state-level changes resulting from policy may differ substantially from the changes in the region.

Key Uncertainties:

As with any assessment of the future, this analysis has many uncertainties. Key uncertainties are related directly to the key assumptions and quantification methods listed above. If those assumptions were incorrect, then the results would change. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

- The shift from fossil fuel generation that would result from a CO2 tax would lead to reductions in criteria air pollutants and, consequently, health impacts and costs associated with those pollutants.
- Shifting from an income tax to a CO2 tax could have economic benefits by encouraging productive activity and discouraging harmful emissions.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

ES-9 Reduce Barriers to Renewables and Clean DG

Policy Description:

Remove barriers to renewables and clean DG including: commercialization barriers; price distortions; failure of the market to value the public benefits of renewables; failure of the market to value the social cost of fossil fuel technologies; and market barriers such as inadequate information, institutional barriers, high transaction costs because of small projects, high financing costs because of lender unfamiliarity and perceived risk, "split incentives" between building owners and tenants, and transmission costs are often higher for renewables.

Policy Design:

Analyzed as RCI-6, Distributed Generation/Combined Heat and Power.

Policies to remove these barriers include: standard interconnection policies; procurement policies (e.g., state power purchases, loading order requirements, long-term contracting with clean DG, etc.); environmental disclosure, etc.

- **Goal levels:** Depends on specific policies to remove barriers.
- **Timing:** Depends on specific policies to remove barriers.
- **Parties:** Depends on specific policies to remove barriers.

Implementation Method(s):

Not considered.

Related Policies/Programs in Place:

None cited.

Type(s) of GHG Benefit(s):

- CO2: By removing barriers to renewables and clean DG, cleaner generation can come into the energy supply mix and displace fossil fuels, thereby reducing CO2 emissions.
- Black Carbon: To the extent that removing barriers to renewables and clean DG lead to displacement of generation from coal and oil, black carbon emissions will decrease.

Estimated GHG Savings and Costs per MTCO2e:

This option is quantified under RCI-6, Distributed Generation/Combined Heat and Power

Data Sources, Methods and Assumptions:

See RCI-6, Distributed Generation/Combined Heat and Power

Key Uncertainties:

See RCI-6, Distributed Generation/Combined Heat and Power

Ancillary Benefits and Costs:

Renewables and clean DG typically keep energy dollars in state, contributing more to employment, fuel diversity and security, and price stability for the state. Water use may be reduced through renewable versus combustion technologies.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

ES-10 Metering Strategies

Policy Description:

There are two common metering strategies and policies: net metering and advanced metering. Net metering is a policy that allows owners of grid-connected distributed generation (generating units on the customer side of the meter) to generate excess electricity and sell it back to the grid, effectively "turning the meter backward." This policy allows for low transaction costs (e.g., no need to negotiate contracts for the sale of electricity back to the utility) and is attractive to DG owners because they are compensated equal to their full cost of purchased electricity (i.e., the sum of wholesale generation, transmission and distribution, and utility administration costs) rather than just the utility's avoided costs.

Advanced metering is a technology that allows electricity consumers much greater opportunity to manage their electricity consumption. For example, consumers could set their meter to turn off or turn down air conditioning during the day while they are away. Coupled with pricing strategies that match prices to reflect actual costs during peak times, advanced metering could be set to automatically adjust demand by turning off lighting or appliances when the price reaches a threshold set by the consumer. A policy could be put into place to encourage the use of advanced metering by subsidizing the meters or by mandating their installation.

Policy Design:

Inasmuch as this is an enabling policy (of clean, distributed generation) as opposed to a reduction policy per se, it is quantified under RCI-6 and RCI-7.

- **Goal levels:** Not applicable.
- **Timing:** Not applicable.
- **Parties:** Utilities and utility customers.

Implementation Method(s):

- Information and education
- Technical assistance
- Funding mechanisms and or incentives
- Market-based mechanisms

Related Policies/Programs in Place:

None cited.

Type(s) of GHG Benefit(s):

- CO_2: By encouraging more clean distributed generation through net metering, and lower demand through advanced metering, there will be less demand for CO_2-intensive central generation, leading to reductions in CO_2 emissions.
- Black Carbon: To the extent that net metering and reduced demand lead to less generation from coal and oil, black carbon emissions will decrease.

Estimated GHG Savings and Costs per MTCO2e:

Not quantified.

Data Sources, Methods and Assumptions:

Not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

- To the extent that metering strategies reduces fossil fuel generation, reductions in criteria air pollutant emissions and, consequently, health impacts and costs associated with those pollutants, would also occur.
- Water use may be reduced through renewable versus combustion technologies.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

ES-11 Pricing Strategies

Policy Description:

Pricing strategies can take many forms including: *real-time pricing* in which utility customer rates are not fixed, but reflect the varying costs that utilities themselves pay for power; *"time-of-use" rates*, which are fixed rates for different times of the day and/or for different seasons; *"increasing block" rates* that are defined by blocks of consumption; *green pricing* whereby customers are given the opportunity to purchase electricity with a renewable or cleaner mix than the standard supply mix offered by the utility; and *advanced metering* to allow electricity consumers much greater opportunity to manage their electricity consumption.

Policy Design:

Analyzed as RCI-8, Electricity Pricing Strategies.

- **Goal levels:** Not applicable.
- **Timing:** Depends on the specific policies.
- **Parties:** Utilities and utility customers.

Implementation Method(s):

- Market-based mechanisms

Related Policies/Programs in Place:

None cited.

Type(s) of GHG Benefit(s):

- CO2: By encouraging less electricity consumption through pricing strategies, generation should be reduced, thereby reducing CO2 emissions. Some pricing strategies, however, may have the impact of increasing CO2 emissions.
- Black Carbon: To the extent that pricing strategies lead to less generation from coal and oil, black carbon emissions will decrease.

Estimated GHG Savings and Costs per MTCO2e:

Not quantified.

Data Sources, Methods and Assumptions:

Not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

To the extent that metering strategies reduces fossil fuel generation, reductions in criteria air pollutant emissions and, consequently, health impacts and costs associated with those pollutants, would also occur. Water use may be reduced through renewable versus combustion technologies.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

ES-12 Integrated Resource Planning

Policy Description:

Integrated Resource Planning (IRP) is a process that diverges from traditional utility least-cost planning. Rather than simply focusing on supply-side options to meet a forecasted growth in emissions, IRP integrates technology and policy options on the demand side with supply side options to satisfy the anticipated demand for energy services. Demand-side measures include energy efficiency, distributed generation, and peak-shaving measures. IRP typically also takes into account a broader array of costs, including environmental and social costs.

Policy Design:

Quantifying CO2 reductions under a policy mandating IRP would require, in effect, conducting integrated resource planning for all utilities in the state, which is beyond the scope of this stakeholder process. Results of a cap and trade policy combined with extensive energy efficiency investments may approximate the results of such a policy. To quantify this option, the CCAG will use a "shadow price" for CO2, to be implemented in the fashion described below.

IRP is an involved process that, by its nature as a bottom-up planning methodology at the utility level, does not lend itself to setting implementation levels per se. The value given to emissions for use in the planning process can be specified, however. In the context of a climate-driven Arizona IRP, a "shadow price" per ton would be assigned to CO2 emissions. In making decisions about which resources to use to satisfy demand for energy services, utilities would be required to apply this "shadow price" as a CO2 adder in their evaluation of technologies and approaches. Utilities would not actually be required to pay this sum.

- **Goal levels:** Implement IRP with a CO2 adder shadow price of $15 per ton of CO2 emitted.
- **Timing:** Not considered.
- **Parties:** Utilities and the ACC.

Implementation Method(s):

- Water use may be reduced through renewable versus combustion technologies.
- Codes and standards

Related Policies/Programs in Place:

No mandated IRP process is in use at this time in Arizona.

Type(s) of GHG Benefit(s):

- CO_2: IRP is a planning process that attempts to factor in the external cost of emissions, including CO_2. Lower emitting technologies are favored as a result. It also treats demand-side efficiency options as equal to supply-side options in the planning process, so fewer or smaller fossil fuel plants may be needed. The end result is potentially significant CO_2 savings.
- Black Carbon: To the extent that generation from coal and oil is reduced under IRP, black carbon emissions will also be reduced.

Estimated GHG Savings and Costs per MTCO2e:

#	Policy	Scenario	Reductions (MMTCO2e)			NPV (2006–2020) $ millions	Cost-Effective-ness $/tCO2
			2010	2020	Cumulative Reductions (2006 - 2020)		
ES-12	Integrated Resource Planning	$15/ton CO2 adder	0.06	5.4	28	-70	-2

Data Sources, Methods and Assumptions:

- **Data Sources:** Data for the electricity modeling done in this analysis comes from the US Energy Information Administration (EIA) and can be found within the National Energy Modeling System (NEMS). Data in NEMS includes representation of the existing generation, transmission and distribution system down to the unit level. NEMS also includes data that characterizes new plants that the model can choose to build to meet projected demand growth. EIA publishes Assumptions to the Annual Energy Outlook that details key assumptions in the current version of the model. EIA also publishes NEMS model documentation.
- **Quantification Methods:** As a proxy for the outcome of an IRP process, we applied a tax of $15 per ton CO_2 to electricity generators at the national level. CO_2 reductions were found by comparing emissions from the policy case to emissions from a reference case. Costs were estimated by comparing policy and

reference case new generating capacity investments, operating and maintenance costs for all generation, fuel costs for all generation, and transmission and distribution costs for all generation. The reported cost for the policy is the net present value of the difference in the above costs between the policy and reference cases. Because the NEMS model captures the CO2 tax in the price of fuel, we simply substituted the reference case price of fuel for the policy case price of fuel, which reflects the CO2 tax. By making this assumption, we are treating the CO2 tax as a shadow price – tax revenues are ignored, but investment and operating decisions are made as if there were a CO2 tax in place. Because the NEMS model is a national model with multi-state regions (Arizona is within the Rocky Mountain Power Area), the results for Arizona were derived from results in the region. We pro-rated the regional emission and cost results according to the share of Arizona generation within the region.

- **Key Assumptions:** Any analysis of state-level policies using the National Energy Modeling System (NEMS) from the US Energy Information Administration should be weighed carefully. NEMS is a national model that consists of 13 regions. State policies cannot be implemented explicitly within NEMS, and the state-specific impacts cannot be known explicitly. We must make assumptions about the impact of policies at the state level by sharing out regional results. In reality, the state-level changes resulting from policy may differ substantially from the changes in the region.

Key Uncertainties:

Key uncertainties are related directly to the key assumptions and quantification methods listed above. Other uncertainties include the forecast of the price of fossil fuels and the growth in the demand for electricity.

Ancillary Benefits and Costs:

IRP attempts to take into account social costs including the impact on the economy as well as health impacts and costs related to criteria air pollution.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

Table 2.
Residential Commercial and Industrial Technical Work Group
Summary List of Completed and Pending Policy Options

#	Policy Name	GHG Savings ($MMtCO_2e$)	Cost-Effectiveness ($\$/tCO_2e$)	Status
RCI-1	Demand-Side Efficiency Goals, Funds, Incentives, and Programs	2010: 3.1 2020: 15.1	- $36	Completed
RCI-2	State Leadership Programs	2010: 0.04 2020: 0.4	- $4	Completed
RCI-3	Appliance Standards	2010: 0.2 2020: 1.0	- $66	Completed
RCI-4	Building Standards/Codes for Smart Growth	2010: 0.3 2020: 2.2	- $18	Completed
RCI-5	"Beyond Code" Building Design Incentives and Programs for Smart Growth	2010: 0.2 2020: 3.1	- $17	Completed
RCI-6	Distributed Generation/Combined Heat and Power	2010: 0.4 2020: 2.7	- $25	Completed
RCI-7	Distributed Generation/Renewable Energy Applications	2010: 0.1 2020: 2.1	$31	Completed
RCI-8	Electricity Pricing Strategies	2010: 1.1 2020: 1.5	-$63	Completed
RCI-9	Mitigating High Global Warming Potential (GWP) Gas Emissions (HFC, PFC)			Completed
RCI-10	Demand-Side Fuel Switching	2010: 0.1 2020: 1.2	TBD	Completed

RCI-11	Industrial Sector GHG Emissions Trading or Commitments	See ES-4	See ES-4	Completed
RCI-12	Solid Waste and Wastewater Management	2010: 2.21 2020: 3.69	Not Quantified	Pending
RCI-13	Water Use Management	2010: 0.23 2020: 0.77	Not Quantified	Pending

Summary Results and Totals for RCI Policy Options

		GHG Reductions (MMtCO2e)			**NPV 2006-2020**
	Policy Name	**2010**	**2020**	**Cost-Eff ($/tCO2e)**	**($million)**
RCI-1	Efficiency Goals, Funds, Incentives, and Programs	3.1	15.1	-$36	-$3,671
RCI-2	State Leadership Programs	0.04	0.4	-$4	-$12
RCI-3	Appliance Standards	0.2	1.0	-$66	-$453
RCI-4	Building Standards/Codes for Smart Growth	0.3	2.2	-$18	-$243
RCI-5	"Beyond Code" Building Design for Smart Growth	0.2	3.1	-$17	-$59
RCI-6	DG/Combined Heat and Power	0.4	2.7	-$25	-$395
RCI-7	DG/Renewable Energy Applications	0.1	2.1	$31	$293
RCI-8	Electricity Pricing Strategies	1.1	1.5	-$63	-$985
RCI-9	Mitigating High (GWP) Gas Emissions		*Not Quantified*		
RCI-10	Demand-Side Fuel Switching	*0.1*	*1.2*		
RCI-11	Industrial Sector GHG Emissions Trading		*Not Quantified*		
RCI-12	Solid Waste, Wastewater Management		*Not Quantified*		
RCI-13	Water Use Management		*Not Quantified*		
	Total Gross Savings	5.7	29.2		-$5,525

Adjustment for Estimated Overlap Between RCI Options			
RCI-2 Overlap with RCI-1	0.00	0.12	-$4
RCI-3, Overlap with RCI-1	0.00	0.00	$0
RCI-4, Overlap with RCI-1 and RCI-2	0.00	0.00	$0
RCI-5, Overlap with RCI-1 and RCI-2	0.08	1.02	-$19
RCI-6 Overlap with Other Quantified Policies	0.00	0.00	$0
RCI-7 Overlap with Other Quantified Policies	0.00	0.00	$0
RCI-8 Overlap with RCI-1	0.29	0.38	-$246
RCI-10 Overlap with RCI-1	0.05	0.36	$0
RCI-12, -13 Overlap with RCI-1	0.00	0.00	$0
Total Estimated Overlap Among RCI Policies	0.41	1.87	-$269
Total Savings Net of Overlaps	5.3	27.4	-$5,255

Please see Attachment 1 for notes on the estimation of savings overlaps between these Policies.

RCI-1 Demand-Side Efficiency Goals, Funds, Incentives, and Programs

Policy Description:

This policy option considers energy savings goals for electricity and natural gas, and the policy, program, and funding mechanisms that might be used to achieve these goals. These are intended to work in tandem with other strategies under consideration by the RCI and ES TWGs.

Policy Design:

This option contains three principal elements – goals, funding and implementation mechanisms, and planning -- along with several supporting activities, as described below.

Goals: Suggested energy savings goals are as follows:

- Electricity (energy savings target): 5% savings by 2010, 15% savings by 2020. These savings targets would be for electricity sales (MWh), and would reflect cumulative (from today), verified savings as a percentage of those years' (projected) loads, starting from the time of policy adoption.
- Natural Gas (utility spending target): ramp up to spending 1.5% of gas utility revenues by 2015.[1] Further decisions by the ACC to decouple gas sales and revenues are viewed as central to achieving this target[2].

Implementation Mechanisms:

Several policy options are commonly used to overcome market, administrative, and institutional barriers to cost-effective efficiency improvements. These options can include public benefit charges, tariff riders, enabling legislation, and/or regulatory directives. They can also work together with state and national tax incentives for energy efficient equipment. Indeed, an evolving and flexible mix of these policy mechanisms may be needed to achieve the efficiency goals described here. The public benefit charge

[1] These targets would apply to all utilities in the state. Electricity and natural gas goals are deliberately expressed in different metrics -- energy savings and revenue targets, respectively – due to recognized differences in experience with efficiency programs with each fuel. Experience with electricity efficiency is sufficient to enable targets to be established, as has been done in several states (e.g. CA and TX). Experience with natural gas efficiency programs is more limited, thus it may be premature to establish energy savings goals.

[2] CCAG members expressed a desire to ensure that these targets are adequately ambitious, and thus to revisit these targets once initial analysis is complete.

approach included in option ES-2 should be considered a leading implementation mechanism, but not the sole one relevant to achieving these goals.

Incorporation of Efficiency in a Planning Context: Inclusion of energy efficiency resource in an integrated resource planning (IRP) process can enable the overall most efficient and cost-effective delivery of energy services. IRP is currently practiced in Arizona, and is under consideration by the ES TWG.

In addition, supporting activities may be important elements in the success of energy efficiency strategies. These supporting strategies could include consumer education and outreach programs (including, for example, enhanced State Energy Office and University-based energy-efficiency extension services), and market transformation programs and organizations. Supporting strategies will be considered as part of overall recommendations, but their impacts will not be quantified. They could also include decoupling utility sales and revenues and creating performance incentives that reward utilities for implementing effective DSM programs.

Related Policies/Programs in Place:

- The ACC recently approved DSM funding by Southwest Gas at a level of 0.8% of revenues.
- Arizona utilities (including APS, SRP, TEP and Southwest Gas) operate a number of DSM programs, including audits, new home programs, shade tree programs, appliance rebates, and others. In addition, the Arizona Department of Commerce's Energy Office provides energy efficiency programs for businesses, communities and homeowners in Arizona.
- In 2004, the Arizona Corporation Commission (ACC) issued a recommended order in a recent Arizona Public Service Co. rate case, supporting a funding level of $16 million per year for APS demand-side management (DSM) programs, an increase from $1 million per year.
- In 2002, Tucson Electric Power was approved to spend $1 million of System Benefits Charge funding for low income and energy efficiency programs
- Arizona home sellers can subtract five percent (up to $5,000) of the sales price of a single family home or condominium that is 50% more efficient than the 1995 Model Energy Code (MEC) from their income for the purpose of calculating their state income tax. The income tax deduction is available through 2010.

Types(s) of GHG Benefit(s):

Principally, the reduction in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Savings and Costs per MTCO2e:

Electricity			
Recent Actions not included in forecast (current/planned efficiency spending levels)			
GHG Emission Savings	**0.3**	**0.9**	MMtCO2e
Impact of Additional Effort in RCI-1			
GHG Emission Savings	**3.1**	**14.9**	MMtCO2e
Net Present Value (2006-2020)		**-$3,617**	$million
Cumulative Emissions Reductions (2006-2020)		103	MMtCO2e
Cost-Effectiveness		**-$35**	$/tCO2e
Other Key Results			
Fraction of Electric Utility Revenues spent on efficiency	**2.6%**	**2.5%**	
Equivalent Public Benefit Charge (electricity)	**1.9**	**1.8**	$/MWh
Electricity Savings Goals (including recent actions)	4,208	18,400	GWh (sales)
Natural Gas			
Recent Actions not included in forecast (current/planned efficiency spending levels)			
GHG Emission Savings	**0.1**	**0.3**	MMtCO2e
Impact of Additional Effort in RCI-1			
GHG Emission Savings	**0.0**	**0.2**	MMtCO2e
Net Present Value (2006-2020)		**-$54**	$million
Cumulative Emissions Reductions (2006-2020)		1	MMtCO2e
Cost-Effectiveness		**-$68**	$/tCO2e
Other Key Results			
Natural Gas Savings Goals (including recent actions)	1,719	10,890	Billion BTU
Combined results for RCI-1 (electricity and natural gas)			
Recent Actions not included in forecast (current/planned efficiency spending levels)			
GHG Emission Savings	**0.4**	**1.3**	MMtCO2e
Impact of Additional Effort in RCI-1			
GHG Emission Savings	**3.1**	**15.1**	MMtCO2e
Net Present Value (2006-2020)		**-$3,671**	$million
Cumulative Emissions Reductions (2006-2020)		103	MMtCO2e
Cost-Effectiveness		**-$36**	$/tCO2e

Discussion: Savings from recent actions reflects the emissions reductions that are likely to accrue from current and planned statewide spending levels on energy efficiency ($12 million/year for electricity; 0.8% of SW Gas natural gas revenues for natural gas). The impact of additional effort in RCI-1 reflects the added statewide economic savings (nearly $4 billion, NPV through 2020) and emissions reductions that would accrue from the statewide goals in this policy measure over and above the current and planned statewide spending levels. The negative cost-effectiveness and NPV reflect a *net benefit* statewide.

The fraction of electric utility revenues spent on efficiency averages about 2.5%. This level of spending is similar to that maintained by utilities in the Pacific Northwest in the 1990s. If this level of spending were translated into a public benefit charge, it would require a public benefit charge on the order of about $2/MWh (0.2 cents or 2 mills per kWh). *[Note that the ES group is discussing a public benefit charge for efficiency and renewables of about 4 mills per kWh.]*

Data Sources, Methods and Assumptions:

See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** Key data sources include USDOE Energy Information Agency (historical and projected prices, SW Gas market share), WGA CDEAC EE Task Force, Northwest Power Council, and California Energy Commission (costs of efficiency programs), SW Energy Efficiency Project (current level of electricity efficiency spending.)
- **Quantification Methods:** The estimation of electricity and natural gas savings (MWh and Mbtu) is relatively straightforward. For electricity, savings are simply the goal times that years' projected loads. For natural gas, projected gas revenues are estimated (based on projected prices and sales), then multiplied by the goal (1.5%) and by the assumed savings per program dollar spent (below). GHG savings are estimated based on marginal emissions rates for electricity (0.7 to 0.8 tCO_2e/MWh – see attachment) and on standard emission rates for natural gas (see inventory). Cost analysis is based on the differential between avoided costs and the levelized cost of efficiency savings.
- **Key Assumptions:** Key assumptions include avoided electricity and gas costs (levelized prices used as a proxy), levelized total costs of efficiency programs ($25/MWh, $2.1/MMBtu), and program spending requirements (6 MWh/yr per $1000 spent, 75 MMBtu/yr per $1000 spent). Another key assumption is that the savings goals apply to all electric and gas utilities in the state.

Key Uncertainties:

- Avoided electricity and natural gas costs.
- Costs and availability of efficiency resources.

Ancillary Benefits and Costs:

These include (WGA CDEAC, 2005)

- Saving consumers and businesses money on their energy bills;
- Reducing dependence on imported fuel sources;
- Reducing vulnerability to energy price spikes;
- Reducing peak demand and improving the utilization of the electricity system;
- Reducing the risk of power shortages;
- Supporting local businesses and stimulating economic development;
- Enabling avoidance of the most controversial energy supply projects;
- Reducing water consumption by power plants; and

- Reducing non-GHG pollutant emissions by power plants and improving public health.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

RCI-2 State Leadership Programs

Policy Description:

'Lead by Example' initiatives help state and local governments achieve substantial energy cost savings while promoting the adoption of clean energy technologies by the public and private sectors.

Policy Design:

The policy action under consideration would include:

- Extension of state building energy savings goals (Statute A.R.S. 34-45) to include a further 15% reduction in energy use per square foot in state buildings from 2011 to 2020, along with purchasing of EnergyStar equipment.
- Standards for new state buildings, with possible design parameters including recommendations for new buildings to be better than code or LEED-related requirements, such as those recommended by the Arizona Working Group on Renewable Energy and Energy Efficiency and by the WGA CDEAC EE[3] Task Force (See also Option RCI-5), as well as mechanisms to support the state in achieving its goals.
- Green Procurement Strategies, such as installation of renewable energy systems as additional backup services in emergency services buildings, and efforts to promote or require the purchase by state buildings of 5% of their building energy needs from renewable sources (over a phased-in period) by 2012, increasing to 10% by 2020[4].
- The promotion of new combined heat and power (CHP) facilities in State Buildings, such as the facilities in place and under construction at Arizona State University and the University of Arizona (approximately 35 MW total), and the

[3] Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association

[4] CCAG members suggested revisiting the green purchase target to ensure that it is adequately ambitious, and to ensure that the state leadership targets, in general, could not be circumvented through outsourcing (that is, that the targets be applicable to private entities working as contractors to the State). Additional policy description text provided below includes a number of additional components including the state ombudsman role noted during the CCAG meeting.

expansion of existing performance contracting law to require life cycle analysis for CHP in State lease-purchase construction.

The TWG suggests that the State Energy Office add staff capability and responsibility for a) ensuring effective compliance with state procurement and savings goals, and b) sharing and communicating the state's accomplishments and lessons learned (a "cooperative extension" role). Furthermore, the state should consider adopting procurement guidance (such as that included in the recent federal energy bill). A number of additional elements of State Leadership programs should be considered as well, as noted at the end of this option.

Additional Recommendations for State Leadership Programs: The following are based on findings of the WGA CDEAC EE Task Force and AZ EE/RE Working Group.

- With respect to the LEED green building standards, the State should investigate the feasibility of requiring additional commissioning and measurement & verification efforts to ensure that they are meeting energy targets.
- The State should construct new buildings that are exemplary and surpass minimum energy code requirements by a wide margin.
- The Governor should use public events, such as installing energy efficiency products in the Governor's residence, or openings of new energy efficient projects, or public awards (energy efficiency or renewable energy awards) to draw attention to the State's renewable energy and energy efficiency ethic.
- The Governor and state agencies should promote the use of State and other public facilities as demonstrations of energy efficiency and renewable energy.
- The State should provide financial and technical assistance for implementation of energy savings projects in existing buildings and facilities.
- The State should use energy service companies (ESCOs) and performance contracting to implement efficiency projects without public sector capital investment.
- The Governor and the Department of Administration should establish a program to install renewable energy systems as additional backup services in emergency services buildings (police stations, fire stations, National Guard facilities).
- The Governor should require state buildings – including schools – to purchase, install and operate cost-effective renewable energy equipment or purchase green power to meet 5% of their building energy needs over a phased-in period by 2012.
- The Governor and State agencies should require State offices to buy a percentage of their electricity from renewable resources, if cost-effective.
- Current law (ARS 34-355) allows the use of cogeneration (combined heat and power) in performance contracting. This law should be expanded to require life cycle analysis for CHP in State lease-purchase construction.

- HB 2430 expands the use of CHP for State facilities and schools. This law (if ultimately adopted) should be built upon in the future.[5]

Implementation Method(s):

These could include, among others, funding mechanisms and incentives, legislation/statutes, codes and standards, and reporting.

Related Policies/Programs in Place:

- Statute A.R.S. 34-451 directs state agencies and universities to achieve a 10% reduction in energy use per unit of floor area by 2008, and a 15% reduction by 2011; purchase cost-effective ENERGY STAR or Federal Energy Management Program-designated energy-efficient products; and meet energy conservation standards developed by the Arizona Department of Commerce's Energy Office.
- HB 2501 "Schools: Energy Efficiency Funds", if adopted, will promote the establishment of energy efficiency funds by schools, with monies deposited by utilities. The funds will be used to purchase energy-efficiency products and services. Schools use utility bill savings to repay the capital cost of energy efficiency measures (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2501_02-15-06_caucuscow.doc.htm).
- Executive Order 2005-05 implementing renewable energy and energy efficiency in new state buildings (http://www.governor.state.az.us/eo/2005_05.pdf)
- A May 2001 Executive Order directed state agencies and employees to implement energy conservation measures in state facilities.

Types(s) of GHG Benefit(s):

To the extent state actions are focused on reducing electricity and natural gas purchases or increasing renewable energy production, GHG impacts are likely to be similar to those described for RCI-1 above.

Estimated GHG Savings and Costs per MTCO2e:

5 http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2430_02-24-06_asengrossedandaspassedhouse.doc.htm

Savings from Recent Actions not included in forecast			
Current state building savings goals	0.16	0.28	MMtCO2e
Recent CHP installations	0.12	0.12	MMtCO2e
Total	**0.28**	**0.39**	MMtCO2e
Impact of RCI-2 Policies			
GHG Emission Savings	**0.04**	**0.39**	MMtCO2e
Net Present Value (2006-2020)		**-$12**	$million
Cumulative Emissions Reductions (2006-2020)		3	MMtCO2e
Cost-Effectiveness		**-$4**	$/tCO2e
Other Key Results			
Green Power Purchased	45	183	GWh (sales)
GHG Emission Savings from Green Power Purchasing	**0.04**	**0.16**	MMtCO2e
GHG Emission Savings from Extending Building Savings Goals	**0.00**	**0.23**	MMtCO2e

Discussion of Results: Savings from recent actions reflect the emissions reductions that are likely to accrue from current state building savings goals and the combined heat and power installations recently installed or coming on line at Arizona universities. Two elements of this policy option are readily quantifiable: extending and deepening the state building energy savings goals from 2011 onward, and green power purchasing. The benefits of promoting CHP at state buildings are incorporated in the overall assessment of commercial CHP potential (see policy RCI-6), and are not reported separately here. Similarly, the benefits of standards for new state buildings are not estimated separately here, but are incorporated in the analysis of new building strategies below (see policies RCI-4 and RCI-5).

The negative cost-effectiveness and NPV reflect an overall net benefit statewide. The cost savings of the extended state buildings goals ($18 million, NPV) more than offsets the net costs of the green power purchasing efforts ($5 million, NPV).

Data Sources, Methods and Assumptions:

See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** The Arizona Department of Commerce (Jim Westberg, Energy Program Administrator) provided estimates of state building energy consumption. The cost of state building efficiency efforts ($47/MWh) is based on the review of relevant literature summarized in the WGA CDEAC Energy Efficiency Task Force report. The incremental cost of green power ($9/MWh) is based on current bulk programs (e.g., Pacificorp's BlueSky program).
- **Quantification Methods:** Emissions savings and costs are calculated in a straightforward manner analogous to RCI-1.
- **Key Assumptions:** State building square footage is assumed to grow at the rate of commercial GSP growth assumed used in the emission forecast (4.9%/year).

Key Uncertainties:

- Avoided electricity and natural gas costs.
- Costs and availability of efficiency resources.
- Incremental costs of green power.
- Rate of growth in state building area.
- Ability to track and enforce building efficiency and green purchasing goals.

Ancillary Benefits and Costs:

Additional impacts are similar to those described for RCI-1 above.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

RCI-3 Appliance Standards

Policy Description:

Implementation of State appliance efficiency standards for appliances not covered by federal standards or where higher-than-federal standard efficiency requirements are appropriate.

Policy Design:

Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards. Arizona, along with several other states, recently adopted state level appliance efficiency standards covering several appliances. State actions led the Federal government to adopt rule making for these appliances in the 2005 energy bill. California has established standards for a number of appliances not covered by Arizona or national legislation, such as pool pumps, consumer electronics (stand-by power use), and general-service incandescent lamps.

The specific policy approach suggested by the TWG is to:

- First, advocate for stronger federal appliance efficiency standards where this is technically feasible and economically justified.
- Second, for those appliances not likely to be covered by federal efforts, pursue efficiency standards already adopted by California and/or other states[6].
- Where possible, consider encouraging local manufacturing of high-efficiency appliances and equipment when adopting state standards.

Implementation Method(s):

Codes and Standards

Related Policies/Programs in Place:

- Arizona Appliance Efficiency Standards [HB2390]
- Existing Federal Appliance Efficiency Standards [2005 Energy Bill]. These federal standards will effectively build upon and replace the Arizona standards for

[6] A CCAG member suggests the consideration of efficiency standards for biomass stoves, solar water heaters, and other renewable energy technologies, as well as for other thermal appliances where efficiency standards do not exist or are inadequate.

the same appliance types. However, the impact of these standards (AZ and federal) is not included in the emissions projections included in the state inventory report.[7]

Types(s) of GHG Benefit(s):

Similar to RCI-1.

Estimated GHG Savings and Costs per Ton:

Recent Actions not included in forecast (current/planned efficiency spending levels)			
GHG Emission Savings	**0.19**	**0.75**	MMtCO2e
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.24**	**0.96**	MMtCO2e
Net Present Value (2006-2020)		**-$453**	$million
Cumulative Emissions Reductions (2006-2020)		7	MMtCO2e
Cost-Effectiveness		**-$66**	$/tCO2e

Data Sources, Methods and Assumptions:

See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** the Appliance Standards Assistance Project and the American Council for an Energy Efficiency Economy draw the results from a recent report.[8] The savings from recent actions (previous AZ efficiency standards) are based on an earlier analysis by the same sources, adapted to the specifications of AZ HB2390[9].
- **Quantification Methods:** The ASAP/ACEEE report uses estimates of appliance sales by states along standard incremental cost and savings analysis to develop state-specific results for 15 specific appliances.[10] The study's NPV results were derived using the same discount rate (5%) as in our analysis, but a longer time span (to 2030). For consistency, the NPV savings were reduced (by about 30%) to reflect the shorter time horizon used for cost analysis in the CCAG process (to 2020).

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[7] The electricity use forecast used in the AZ GHG emissions projections is based on DOE's 2005 Annual Energy Outlook, which did not take these standards into account.

[8] ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards", http://www.standardsasap.org/stateops.htm .

[9] A TWG member provided a copy of this analysis.

[10] See http://www.standardsasap.org/a062_az.pdf for a table listing the 15 appliances considered, and their costs and savings. The carbon emissions savings shown in this document are not used, instead the marginal electricity emission factors used for other CCAG policies are used.

- **Key Assumptions**: The ASAP/ACEEE study used prices slightly different than used for the CCAG analyses – they use 9.0c/kWh ($13.52/Mbtu gas) residential and 7.6c/kWh ($9.65/Mbtu gas) commercial. The resulting NPV savings differ slightly from those that would be obtained using our avoided delivered electricity and gas cost estimates[11].

Key Uncertainties:

- Ability to track and enforce compliance with standards.
- Avoided electricity and natural gas costs.

Ancillary Benefits and Costs:

Similar to RCI-1.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[11] The authors of the ASAP/ACEEE study have agreed to re-estimate the cost impacts based on the electricity and gas prices used for the CCAG analysis – updated results to be reported when available.

RCI-4 Building Standards/Codes for Smart Growth

Policy Description:

Given the State's growth and the long lifetime of buildings, the current and future building codes will have a considerable impact on future energy use in buildings, and on related greenhouse gas emissions, thus improved and increasingly stringent energy efficiency codes for Arizona are proposed.

Policy Design:

Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation[12]. It is recommended that Arizona take the following actions in order to realize the energy savings and other benefits offered by state-of-the-art building energy codes[13]:

- Arizona should either establish a statewide mandatory code or strongly encourage local jurisdictions to adopt and maintain state-of-the-art codes. Adoption is targeted for 2007, with codes in force in early 2008, but with the recognition that some municipalities in Arizona may implement energy efficiency codes later than others.
- Arizona and/or local jurisdictions should adopt the 2004 International Energy Conservation Code (IECC), to the extent that adoption has not already occurred. Also, Arizona and/or local jurisdictions should consider adopting innovative features of California's latest Title 24 building energy codes, such as lighting efficiency requirements in new homes. In considering the adoption of building code elements, Arizona and/or local jurisdictions should take into account the time-dependent value of energy by, for example, noting the extra benefits from code revisions that are particularly effective in saving on-peak electricity or gas.
- Arizona and local jurisdictions should update energy codes regularly. A three-year cycle could be timed to coincide with release of the national model codes.
- Revised building codes for Arizona as a whole and for local jurisdictions should be prepared with the involvement of local chapters of code organizations to assist

[12] A CCAG member noted that the threshold for major renovation needs to be further defined. This issue should be addressed as this policy is further detailed and as implementation plans are developed.
[13] Many of these suggestions are consistent with recommendations included in the WGA CDEAC EE report (for example, page 59).

in obtaining support for and compliance with the new policies. All buildings will be covered, including manufactured homes, and local building inspectors will enforce compliance with codes. Inspectors need to be properly trained in new elements of the codes.

Implementation Method(s):

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, local officials, and others in the building industry, including training on building energy performance analysis tools and software. Would also include programs for consumer and elementary/secondary education.
- Training and technical assistance for code enforcement officials, including training and assistance in the use of building energy performance analysis tools and software, and in the review and analysis of the outputs of building energy performance tools.
- Funding mechanisms and or incentives: Utility programs (designed to encourage building energy performance beyond codes) may help to provide financial assistance for training code officials in the application of building energy codes. Increases in permit fees and/or increase in "impact fees" may also be considered to assist with funding of training for code officials.
- Voluntary and or negotiated agreements: Agreements within Metropolitan Area Government councils to collaborate on building energy codes in order to make compliance easier for building contractors and other building trade professionals.
- Codes and standards—In addition to adoption of state and/or local and/or metropolitan area building energy performance codes, Arizona may consider starting a State Building Energy Codes Collaborative process and/or joining a Regional Building Codes Collaborative, as referenced (for example) on pages 65-66 of the WGA CDEAC EE report.

Related Policies/Programs in Place:

Code changes advanced in some localities, beginning in others. Most urban areas have adopted the IECC 2004 codes, and some (notably Tucson) have adopted more stringent codes.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Savings and Costs per MTCO2e:

Recent Actions Not Included in Forecast (Current/planned building code changes)			
GHG Emission Savings	**1.0**	**3.9**	$MMtCO_2e$
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.3**	**2.2**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$243**	$million
Cumulative Emissions Reductions (2006-2020)		13.7	$MMtCO_2e$
Cost-Effectiveness		**-$17.70**	$/t$CO_2e$

Discussion of Results: Savings here are relatively modest in part because significant improvements over codes in place in the last few years are expected as a part of the WGA CDEAC EE Reports "Current Activities" case, and the savings reported here are the different between the "Current Activities" case (used as the basis for the estimate of "Recent Action" impacts shown above) and the more aggressive "Best Practices" case. Savings in emissions related to reduced electricity consumption account for well over 90 percent of the GHG savings from this policy.

Data Sources, Methods and Assumptions:

- **Data Sources:** Major data sources include the WGA CDEAC EE report, including background materials for that report developed by the Building Code Assistance Project (BCAP), The Southwest Energy Efficiency Project's (SWEEP) Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices, and results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Results from the WGA CDEAC EE analysis at the State level were adjusted to achieve the results above. See Attachment 1 for further details.
- **Key Assumptions:** Level of code improvements assumed same as in the WGA CDEAC EE analysis, though parameters are included to allow adjustments of those assumptions. The cost of electricity savings through building code improvements, beyond "baseline values", was assumed to be 4.7 cents/kWh on a levelized basis (same source). Savings in the commercial sector assumes that at least some renovated space is included in code requirements, and that the ratio of renovated space included in energy code requirements to new space included is 0.3. Ratio of gas to electricity savings as in the SWEEP Report, above.

Key Uncertainties:

The degree to which improved codes in Arizona may be similar to those assumed in the WGA CDEAC EE analysis. Results have not yet been adjusted for the degree to which statewide code adoption will be different in different parts of the state, due to varying weather regimes.

Ancillary Benefits and Costs[14]:

- Saving consumers and businesses money on their energy bills
- Potential to also yield water savings
- Comfort/indoor air quality improvements, with related improvements in health and productivity
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses and stimulating economic development
- Low-income populations living in buildings covered by the policy will benefit through lower annual energy costs.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[14] Many of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

RCI-5 "Beyond Code" Building Design Incentives and Programs for Smart Growth

Policy Description:

Building energy performance standards are implemented in State-funded and other (such as local) government buildings, and similar standards are promoted in other buildings, such that new buildings achieve high standards of energy efficiency, and existing buildings are renovated or retrofitted to yield significant energy efficiency improvements.

Policy Design:

Implementation of LEED (Leadership in Energy and Environmental Design) standards/certifications and/or other "green building" certifications and/or measured or modeled building energy performance criteria may be used to specify building energy performance standards[15]. Implementation of white roofs, rooftop gardens, and landscaping (including shade tree programs would also be covered by this policy. In addition to directly influencing energy use in state-funded and government buildings, this policy will help to raise awareness of energy-efficiency improvement methods in building construction and operation, and will help to "drive" such improvements in other market segments. This policy includes:

- A performance standard for State-owned or state-leased buildings to demonstrate the feasibility of not only achieving the minimum code requirements but also exceeding them. This will demonstrate and encourage the use of advanced energy efficiency products and designs, and will also reward the State with the inherent benefits of more efficient buildings. New state-owned or state-leased buildings will be required to use at least 10 percent less energy per square foot of floor space relative to what the same building would have used if designed to just meet existing energy codes. The requirement of 10 percent lower energy use will be reviewed periodically, but is expected to remain in force as long as the level of improvement remains cost-effective.
- A requirement that state-owned or leased facilities use life-cycle costing, including full consideration of future energy costs, in the selection and implementation of building designs and components for both new and renovated space, or for the selection of replacement components. Further, following life

[15] Note that it is not the intent of this policy that achieving LEED or other certifications be required in order to receive incentives, so long as a project achieves an adequate level of energy savings.

cycle cost analysis, require that the most cost-effective design/equipment/component options be chosen.

- Provide financial or tax incentive for non-pubic and non-state public buildings (such as municipal buildings) to improve their energy performance beyond that required by existing codes[16]. Incentives should be provided for building projects (new, renovated, or remodeled space) where energy consumption per unit floor area is at least 10 percent less that would be the case if the project just met existing codes, noting that energy codes will change over time[17]. Incentives should be structured so that projects that produce higher savings per unit floor area relative to just meeting code requirements receive greater incentives.
- Provide similar financial or tax incentives to encourage retrofits of existing buildings to levels of energy efficiency exceeding those required by existing energy codes.
- Performance standards, life cycle costing requirements, and incentive programs to begin at some point to be determined in the future.

Implementation Method(s):

- Information and education: Would include training and education programs and certification for state officials, building planners, builders/contractors, energy managers and operators, and local officials on certification that buildings and building subsystems have met program requirements. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance to building planners, engineers, and others in energy-efficient design and in building energy efficiency analysis, possibly including reference materials, performance/design guidelines, and assistance with energy performance analysis software.

[16] There are, as of the writing of this Policy Description, a number of ongoing discussions regarding the LEED certification program, other certification programs, and potential performance guidelines for new and renovated buildings, and as a result, it is not yet clear which certifications or performance guidelines might be adopted or suggested for use in this program. Whichever set of certifications/performance guidelines are adopted should provide designers, builders and contractors with a means to advertise that their work meets a high energy-efficiency standard (through a specific labeling or certification), while also assuring that the actual energy performance of the building significantly exceeds the level required by codes.

[17] A CCAG member noted that even in the absence of a building energy code improvement policy, energy codes will improve over time, and this “baseline” improvement will need to be taken into account in quantifying the benefits and costs of policies to improve building energy efficiency.

- Funding mechanisms and or incentives: Tax credits and/or incentives related to the rate of amortization of expenses related to buildings or renovation. State grants to help cover additional costs of energy performance enhancements for municipal government buildings.
- Voluntary and or negotiated agreements: Agreements by municipal governments, builders to meet higher energy performance standards in exchange for special certification and/or financial incentives.
- Codes and standards: For state-owned or state-leased space, requirements to exceed codes in force as noted above.
- Pilots and demos: Applications of building energy performance improvements (possibly including demonstration of construction of buildings to LEED or other relevant standards) and urban landscaping for government buildings.

Related Policies/Programs in Place:

[Note that many of the state programs listed below are either very recently enacted or currently under consideration, and thus may effectively constitute "new" State GHG policies rather than "BAU" policies]:

- Related notes in early version of RCI TWG Policy Matrix: "Executive Order 2005-05 implementing renewable energy and energy efficiency in new state buildings; Solar Design Standards for State Buildings; Tucson-Pima Sustainable Energy Program; City of Scottsdale Green Building program"
- Notes in early version of RCI TWG Policy Matrix related to professional education/certification: APS and state Energy Office offer building science training; APS subsidizes contractor training; Energy office provides training [in building codes]; • Technical assistance from Rebuild Arizona and Arizona Energy Office [for energy management/building operator training]
- Newly-adopted Federal Energy Credit for houses "that reduce energy use for heating and cooling only (not hot water) by 50% compared to the national model code — the 2004 IECC Supplement", as well as for commercial buildings that "achieve a 50% reduction in annual energy cost to the user, compared to a base building defined by the industry standard ASHRAE/IESNA 90.1-2001"
- Legislation proposed as HB 2858 including a LEED standard for schools, and including methods by which the degree to which schools meet the standard will be monitored.
- Legislation proposed as HB 2430 emphasizing life cycle costing.
- Legislation proposed as HB 2429 for solar tax credits.
- Legislation proposed as HB 2843 for tax credits for high-efficiency residential central air conditioners and ceiling fans (as well as clothes washers).

- Legislation proposed as HB 2324 and recently enacted as ARS 34-451 setting energy efficiency standards for new and existing public buildings.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Savings and Costs per MTCO2e:

Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.2**	**3.1**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$314**	$million
Cumulative Emissions Reductions (2006-2020)		18.4	$MMtCO_2e$
Cost-Effectiveness		**-$17.11**	$\$/tCO_2e$

Discussion of Results: Commercial sector measures account for over half of total reduction in electricity use (and thus GHG emissions reductions). GHG emissions savings from avoided electricity generation account for over 90 percent of total reductions.

Data Sources, Methods and Assumptions:

- **Data Sources:** Major data sources include the WGA CDEAC EE report, including background materials for that report developed by the Building Code Assistance Project (BCAP), The Southwest Energy Efficiency Project's (SWEEP) Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices, and results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Quantification starts with an estimate of average electricity use per household and per unit commercial floor space after taking into account changes due to improved energy codes, then applies participation estimates and fractional savings assumptions to estimate potential savings, first in new construction, and then, through application of factors to reflect the participation of other types of buildings (existing, space, renovated space), estimates an overall level of electricity savings. Gas savings are estimated from electricity savings based on SWEEP data (from document above). See Attachment 1 for details.
- **Key Assumptions:** Cost of beyond-code improvements assumed to be similar to improvements needed to attain the higher codes included in RCI-4. “Beyond-code”

savings assumed to save 15 percent of household and commercial electricity use (initial assumption).

Key Uncertainties:

Levels of participation and savings achieved by policy in different sectors and markets.

Ancillary Benefits and Costs[18]:

- Potential to also yield water savings, comfort/indoor air quality improvements with related improvements in health and productivity, plus urban design, market transformation, and other benefits.
- White roofs, rooftop gardens, and landscaping, if widely implemented, may have a favorable impact on local climate, for example, reducing nighttime temperatures, potentially allowing a further reduction in energy use for space cooling ("urban heat island" effects).
- Saving consumers and businesses money on their energy bills
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses and stimulating economic development
- Low-income populations living in buildings covered by the policy will benefit through lower annual energy costs.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[18] Many of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

RCI-6 Distributed Generation/Combined Heat and Power

Policy Description:

Distributed generation with clean combined heat and power systems improves the overall efficiency of fuel use as well as electricity system benefits. Implementation of these systems should be encouraged through a combination of regulatory changes and incentive programs.

Policy Design:

Distributed generation in the form of clean combined heat and power systems give electricity consumers the capability of generating electricity or mechanical power on-site to meet all or part of their own needs, sell power back to the grid, and, through capture of heat typically lost during power generation, meet on-site thermal needs (hot water, steam, space heat, or process heat) or cooling (for example, through application of absorption chillers)[19]. In so doing, distributed generation with combined heat and power (CHP) raises the overall efficiency with which fuel is used. In addition to improvements in the efficiency of fuel use, and related reduction in greenhouse gas emissions, expanded use of distributed CHP offers significant electricity system benefits (including avoided electricity transmission and distribution losses, and avoided requirements for electricity grid expansion). Policies to encourage the adoption of CHP include a combination of regulatory changes and possibly incentives for adoption of CHP systems. CHP systems of 10 MW or smaller (or of equivalent mechanical power) would be covered, and policies in place by the end of 2006, and in force thereafter, with periodic review as needed. The combination of regulatory changes and incentives will be designed to allow a certain percent of Arizona's estimated remaining CHP potential to be realized at some in the future.

Implementation Method(s):

[Note that in the list of incentives below technical assistance, codes and standards, market-based mechanisms, and utility planning (in that order) are considered by TWG members to be of primary importance, while other mechanisms are considered of secondary importance.]

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, and state and local officials related to the incorporation of CHP into

[19] The CCAG suggested that this policy option could be expanded to include on-site electricity generation from waste heat.

building plans/designs/operation. Would also include programs for consumer and elementary/secondary education.

- Technical assistance: Assistance in siting and planning CHP systems.
- Funding mechanisms and or incentives: A program similar to that offered in California with up to $500 per kW or equivalent incentives per horsepower (hp) of capacity is possible. Another possible financial incentive is production incentives as included in the proposed legislative bill (HB 2427) of $0.015 per kWh or equivalent incentives per hp-hour.
- Voluntary and or negotiated agreements
- Codes and standards: A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national interconnect standard for installation to transmission lines. A number of other states, including Texas, California, New Jersey, New York- have adopted interconnect standards to facilitate DG installation. A similar standard is needed in Arizona, and has recently been under discussion at the ACC[20].
- Market based mechanisms: Net metering, avoided-cost pricing rules, and/or other utility tariff policies that promote CHP. Performance contracting is another possible mechanism, for example, HB 2430 expands the definition of allowed performance contracting for State facilities and schools to include the use of CHP, and extends the allowable payback period to 25 years (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2430_02-24-06_asengrossedandaspassedhouse.doc.htm).
- Pilots and demos: CHP systems in government buildings.
- Research and development: Support for research on combined power and cooling systems most germane to Arizona
- Utility Planning: Include CHP as an element of resource planning for utilities.

Related Policies/Programs in Place:

Interconnection rules and similar topics are under discussion at the Arizona Corporation Commission (ACC).

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O: from avoided fuel combustion, net of any

[20] Includes in part text provided by the Distributed Energy Association of Arizona.

increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control equipment used on CHP and heating systems.

Estimated GHG Savings and Costs per MTCO2e:

Total for Policy (All Fuels)				
Total Net GHG Emission Savings		**0.37**	**2.70**	$MMtCO_2e$
Net Present Value (2006-2020)			**-$395**	$million
Cumulative Emissions Reductions (2006-2020)			15.5	$MMtCO_2e$
Cost-Effectiveness			**-$25.41**	$/tCO_2e$

Discussion of Results:

Net emissions reduction as calculated include consideration of avoided central station electricity generation, avoided on-site fuel use (including electricity use) for heating (or cooling) displaced by co generated heat and additional fuel used by CHP systems. Commercial sector measures account for over half of total reduction in electricity use (and thus GHG emissions reductions). Similarly, GHG emissions savings from avoided electricity generation account for over 90 percent of total reductions.

Data Sources, Methods and Assumptions:

- **Data Sources:** The Combined Heat and Power White Paper**,** dated January, 2006, to the Clean and Diversified Energy Initiative of the Western Governors Association; and the 2003 Commercial Buildings Energy Consumption Survey Detailed Tables, published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Starting with an estimate for Arizona's share of CHP potential in the West, as provided in the "CHP White Paper" referenced above, assumptions regarding the penetration of and fuel shares for new CHP systems, estimates of future capacity of CHP developed under the policy are generated. Estimates of CHP cost and performance for different kinds of systems are then used to estimate the overall net GHG emissions reduction and net cost of the policy.
- **Key Assumptions:** Gas-fired systems are assumed to dominate new CHP in Arizona, but some biomass- and coal-fired capacity is also included. Systems are assumed to operate an average of 5000 hours per year (at full capacity), and 90 percent of co-generated heat is assumed to be usable (and displaces heat from purchased fuels).

See Attachment 1 for additional information on assumptions, methods, and sources.

Key Uncertainties:

Achievable rate of implementation of CHP systems in Arizona, types and amounts of heating fuels that will be displaced, and average future costs of systems.

Ancillary Benefits and Costs[21]:

- Potential increased reliability of electricity supply for CHP hosts, increased flexibility of supply.
- Central-station power plant cooling water savings
- Potential local air quality impacts (may be positive or negative)
- Saving consumers and businesses money on their energy bills
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses (related to distributed generation/CHP sales, installation, and service) and stimulating economic development

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[21] Many of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

RCI-7 Distributed Generation/Renewable Energy Applications

Policy Description:

Distributed generation sited at residences and commercial and industrial facilities, and powered by renewable energy sources, provides electricity system benefits and displaces fossil-fueled generation, thus reducing greenhouse gas emissions. Increasing the use of renewable distributed generation in Arizona can be achieved through a combination of regulatory changes and incentives.

Policy Design:

Customer-sited distributed generation powered by renewable energy sources provides electricity system benefits such as avoided capital investment and avoided transmission and distribution losses, while also displacing fossil-fueled generation and thus reducing greenhouse gas emissions. Customer-sited renewable distributed generation can include solar photovoltaic systems, wind power systems, biogas and landfill gas-fired systems, geothermal generation systems, and systems fueled with biomass wastes or biomass collected or grown as fuel. Policies to encourage and accelerate the implementation of customer-sited renewable distributed generation include direct incentives for system purchase, market incentives—including “net metering”--related to the pricing of electricity output by renewable distributed generation, state goals or directives, and favorable rules for interconnecting renewable generation systems with the electricity grid. Non-electric renewable energy applications also covered by this policy include solar water heat and solar space heat and cooling. It is suggested that Arizona should, at a minimum, set as its target the addition of customer-sited distributed renewable generation consistent with the overall generation capacity by year goals for renewable distributed generation in the West as expressed in the WGA CDEAC reports.

It is expected that implementing agencies will include Public Agencies (systems for state or other government buildings), the Arizona Corporation Commission[22], Arizona State Government, and Utilities.

Implementation Method(s):

[22] In addition to the ACC’s influence on interconnection and pricing rules that will have a significant impact on the adoption of customer-sited distributed generation, decisions by the ACC on reserving a portion of the Environmental Portfolio Standard to be supplied by customer- sited DG systems will also have an impact on the future implementation of DG renewable energy.

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, renewable energy contractors, and state and local officials on the incorporation of distributed renewable generation and solar space/water heat in building projects. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance in siting, designing, planning renewable systems
- Funding mechanisms and or incentives: These might include low-interest loan programs, rebates on capital costs, tax incentives, attractive rates for power purchases/net metering, and other incentives.
- Voluntary and or negotiated agreements
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national standard interconnect standard for installation to transmission lines. In addition, States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[23].
- Market based mechanisms: Net metering for some renewable distributed generation systems, and avoided-cost pricing rules for others[24]*[?]*
- Pilots and demos, such as renewable systems in government buildings
- Research and development: Support for development of distributed renewable generation systems most germane to Arizona.
- Regulatory: Complete Environmental Portfolio Standard (EPS) process at the Arizona Corporation Commission, and complete Sustainable Energy process at the Salt River Project.[25]

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[23] Includes in part text provided by the Distributed Energy Association of Arizona.
[24] TWG members identified the need to coordinate with and support the ongoing ACC process on net metering as an important means toward achieving substantial use of distributed generation in Arizona. HB 2427 entitled "Tax Credit; Renewable Energy" creates new state income tax credits of 1.5 cents per kWh of electricity generation (and 1.1 cents per hp-hr of mechanical energy produced), beginning in 2007, for individual or corporate taxpayers who produce and sell power from "qualified energy resources", including solar, wind, closed-loop biomass, geothermal, small irrigation power, and combined heat and power. See http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2427_02-21-06_caucuscow.doc.htm
[25] Includes in part text provided by the Distributed Energy Association of Arizona.

Related Policies/Programs in Place:

Salt River Project's Solarwise program; TEP and UES Sunshare PV buydowns; Arizona's state Solar and Wind Equipment Sales Tax Exemption; and existing Solar and Wind Energy Systems Tax Credits.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided fossil-fueled electricity production.
- Modest reduction in emissions of CH_4 from avoided fuel combustion in electricity generation and avoided natural gas pipeline leakage. Likely small reductions in N_2O and Black Carbon emissions from avoided fuel combustion in electricity generation.

Estimated GHG Savings and Costs per MTCO2e:

Total for Policy (All Fuels)			
Total Net GHG Emission Savings	**0.10**	**2.07**	$MMtCO_2e$
Net Present Value (2006-2020)		**$293**	$million
Cumulative Emissions Reductions (2006-2020)		9.6	$MMtCO_2e$
Cost-Effectiveness		**$30.62**	$\$/tCO_2e$

Discussion of Results: Net emissions reductions as calculated include consideration of avoided central station electricity generation, less modest net GHG emissions from additional fuel use (biomass, biogas, and landfill gas). Most of the costs and savings from this policy are from installation of solar PV systems; under current assumptions, a cumulative 850 MW of Solar PV are installed through 2020.

Data Sources, Methods and Assumptions:

- **Data Sources:** Arizona "State Fact Sheet" from the Southwest Energy Efficiency Project's Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices; USDOE/EIA document 2003 Commercial Buildings Energy Consumption Survey Detailed Tables; Worksheet "Solar Homes Summary table.xls", with calculations in support of the California Million Solar Homes Initiative, authored by XENERGY, Inc., and provided by M. Lazarus; Arizona Consumer's Guide to Buying a Solar Electric System, from the Arizona Solar Center; sources with information on Photovoltaic costs.
- **Quantification Methods:** Projection of the number of new and existing homes, and new and existing commercial floor space, in Arizona through 2020 were coupled with an initial estimate for the penetration of solar PV panels and estimates of solar PV current and future costs to yield estimates of solar PV capacity and performance by year.
- **Key Assumptions:** Rates of growth of housing and commercial floor space; addition of residential and commercial PV systems at a penetration rate roughly

consistent with that assumed for the "Million Solar Homes" initiative in California; annual solar capital cost reductions of about 5 percent, and addition of a total of 10 MW of new customer-sited biomass/landfill gas/biogas-fueled capacity per year by 2020.

See Attachment 1 for additional information on assumptions, methods, and sources.

Key Uncertainties:

Future solar PV costs, solar PV penetration rates.

Ancillary Benefits and Costs[26]:

- Increased flexibility of electricity supply for consumers hosting generation.
- Central-station power plant cooling water savings
- Potential local air quality impacts (may be positive or negative, depending on technology)
- Saving consumers and businesses money on their energy bills (and/or offering a new income stream)
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Where waste biomass fuels are used, possible reduction in disposal cost, reduction in environmental impacts related to disposal
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related health improvements
- Supporting local businesses (related to renewable system sales, installation, and service, and possibly biomass fuel supply) and stimulating economic development.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[26] Some of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC Energy Efficiency Task Force report.

RCI-8 Electricity Pricing Strategies

Policy Description:

Adjustments in electricity pricing to reflect the true time-dependent cost and value of generation are suggested as means to both lower the overall costs and emissions from electricity system operation and to encourage the implementation of clean customer-sited combined heat and power and distributed generation.

Policy Design:

As with other energy and non-energy commodities, the pricing of electricity—including electricity from the grid used by consumers and electricity generated on the consumers' premises flowing to the grid—can have a significant impact on consumers' usage decisions. Proper and clear electricity tariffs and price signals can provide significant encouragement to distributed generation, energy conservation (in many forms), and reduction of electricity use during times of peak electricity demand. Creating such tariff structures may involve restructuring tariffs to provide incentives for "shoulder[27]" and peak demand reduction—for example, through implementation of time-of-use energy charges—as well as setting net metering or other rules for sales from distributed generation to the grid that provide appropriate credit for the electricity generated during periods of high power demand[28]. Changes in tariff structures are also needed that revise the balance between energy and demand charges and change the way that demand charges are fixed. These changes should be designed so as to provide improved incentives for end-users to adjust the timing of energy use so as to reduce greenhouse gas emissions as much as possible. The initiation of inverted block rates, where higher tariffs are charged once electricity use per household (for example) reaches a threshold level each month, is also recommended.

These tariff and pricing changes should be implemented by a set date in the future so as to remove barriers to and create incentives for customer-sited CHP and renewable generation as soon as possible. Note that it will likely not be possible to isolate the impacts of these tariff and pricing changes from policies such as RCI-1, RCI-2, RCI-6, and RCI-7, and as such the costs and impacts of these tariff and pricing policies will likely be taken into account in the quantification of costs and impacts other RCI policies

[27] "Shoulder" periods of electricity demand occur in the periods before and after the period of daily system peak power demand.
[28] A CCAG member noted that tariff changes that result in a shift in demand will not necessarily result in a reduction of carbon emissions from electricity generation, as emissions changes will depend on which generation units are affected by shifts in load.

(which RCI-8 policies support). To avoid double counting, then, the costs and impacts of tariff and pricing changes (with the exception of inverted block rates) will not be quantified separately[29].

Implementation Method(s):

Note that in the list of incentives below, rate designs, codes and standards, market-based mechanisms, and funding mechanisms and/or incentives (in that order) are considered by the TWG to be of primary importance, while other mechanisms are considered of secondary importance.

- Information and education: Would include programs for consumer education, information for distributed generation hosts.
- Technical assistance: Assistance to consumers/potential distributed generation hosts in economic analysis of potential systems
- Funding mechanisms and or incentives: Pricing incentives/TOU pricing
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national interconnect standard for installation to transmission lines. In addition, several States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[30].
- Market based mechanisms: Net metering for some renewable distributed generation/CHP systems, avoided-cost pricing rules for others, TOU tariffs. Inverted block rates to spur conservation of electricity use by households using above-average quantities of electricity.
- Pilots and demos: Pilot TOU rate implementation, and pilot renewable and CHP systems in government buildings, with tracking of costs/income
- Research and development: Support for development of electricity pricing systems
- Rate Designs: Incorporate new rate designs in current DG Workshops and upcoming APS rate case. Legislative action may be needed requiring new Salt River Project standards be implemented.

Related Policies/Programs in Place:

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[29] A CCAG member suggested that those pricing strategies that result in a net reduction in electricity consumption might result in quantifiable savings, and suggested that "moderate importance" be placed on further investigating such strategies, and that the topic be addressed in the next RCI TWG meeting.
[30] Portions of this description were adapted from text provided by the Distributed Energy Association of Arizona through TWG member Penny Allee Taylor.

APS Commercial Peak Reduction Campaign

Types(s) of GHG Benefit(s):

Policy contributes to:

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O: from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control equipment used on CHP and heating systems.

Estimated GHG Savings and Costs per Ton (quantified for inverted block rates only):

Total for Policy (All Fuels)				
Total Net GHG Emission Savings		**1.1**	**1.5**	$MMtCO_2e$
Net Present Value (2006-2020)			**-$985**	$million
Cumulative Emissions Reductions (2006-2020)			15.6	$MMtCO_2e$
Cost-Effectiveness			**-$62.96**	$/tCO_2e$

Data Sources, Methods and Assumptions:

- **Data Sources:** For impacts of inverted block rate and similar tariff structures, the SWEEP "New Mother Lode" study provides one of the few available estimates, and is thus used here. Studies of similar programs in Utah and elsewhere may be used in the future to estimate the impacts of the inverted block rate element of this policy.
- **Quantification Methods**: Note that it will likely not be possible to isolate the impacts of these tariff and pricing changes from policies such as RCI-1, RCI-2, RCI-6, and RCI-7, and as such the costs and impacts of these tariff and pricing policies will likely be taken into account in the quantification of costs and impacts other RCI policies (which RCI-8 policies support). The net impacts of TOU rates may be positive or negative, but probably should be assessed as a part of other policies. To avoid double counting, then, the costs and impacts of tariff and pricing changes will likely not be quantified separately. Inverted block tariff structures, which may yield significant overall demand reduction, are quantified based on the estimated monthly savings from implementation of an aggressive, but revenue-neutral, tariff structure.

- **Key Assumptions:** Impact of suggested policies on uptake of consumer -sited CHP and renewable generation in Arizona; impact of TOU rates on utility load curves.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs[31]:

- Increased flexibility of electricity supply for consumers hosting generation.
- Central-station power plant cooling water savings
- Potential local air quality impacts (may be positive or negative, depending on technology)
- For pricing that induces new distributed generation, saving consumers and businesses money on their energy bills (and/or offering a new income stream)
- Some pricing structures may have negative impacts on low-income consumers—need to adopt rate designs or mitigating programs to address such impacts as a part of implementation strategies.
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Where waste biomass fuels are used, possible reduction in disposal cost, reduction in environmental impacts related to disposal
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related health improvements
- Supporting local businesses (related to renewable system sales, installation, and service, and possibly biomass fuel supply) and stimulating economic development

Feasibility Issues, if applicable:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[31] Some of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC Energy Efficiency Task Force report.

RCI-9 Mitigating High Global Warming Potential (GWP) Gas Emissions (HFC, PFC)

Policy Description:

A combination of voluntary agreements with industries and of new specifications for key equipment is suggested to reduce the emissions of process gases that have high global warming potential.

Policy Design:

Based on a review of available options to further reduce high-GWP gas emissions in the RCI sectors, the TWG suggests further consideration of specifications for new commercial refrigeration equipment.[32] Such specifications and possible voluntary incentives—now under consideration and analysis by the California Air Resources Board—would: a) promote the use of low GWP refrigerants[33] in refrigerators in retail food stores, restaurants, and refrigerated transport vehicles (trucks and railcars); and/or b) require or provide incentives that centralized systems with large refrigerant charges and long distribution lines be avoided in favor of systems that use much less refrigerant and lack long distribution lines.[34] It is specifically recommended that the Governor explore working with California and other states in addressing HFC emissions from refrigeration.

[32] Based on the current AZ emissions inventory and projection, GHG emissions from hydrofluorocarbons (HFCs) could grow from about 1 $MMtCO_2e$ or <1% of Arizona GHG emissions in 2000 to over 7 $MMtCO_2e$ or about 5% of state emissions by 2020. Most HFC emissions are expected to result from leaks in mobile air conditioning and refrigeration applications. Other sources of high Global Warming Potential (GWP) gases, which include the emission of perfluorocarbons (PFCs) and HFCs and from semiconductor manufacture and leakage of sulfur hexafluoride (SF6) from electricity distribution equipment, contribute less to state emissions, and these emissions are expected to decline based on existing emission reduction efforts, such as the semiconductor industry's voluntary worldwide agreement.

[33] Examples include lower GWP HFCs, carbon dioxide, and hydrocarbons (propane or isobutene/propane blend).

[34] A CCAG member suggested following up in additional detail the specifications for using substitute for high-GWP gases now being discussed or in place in California, and which might be considered for Arizona. Another CCAG member noted that there are existing data on reduction of PFC use in the electronics industry that should be reviewed by the TWG. Also mentioned by the CCAG was the desire to consider progress in the reduction of SF_6 use in the electric utility sector.

While a focus on commercial refrigeration emerged from TWG discussions, participants also noted that maintaining momentum of voluntary industry-government partnerships (such as the semi-conductor industry agreement) should be a high priority.

Implementation Method(s):

These could consist of hybrid approach, combining market-based incentives and codes and standards (specifications).

Related Policies/Programs in Place:

- The Intel voluntary agreement noted above is producing significant reductions in PFC emissions from semiconductor manufacturing. Intel estimates that, in their Arizona operations, PFC emissions will be reduced 0.22 MMtCO2e below 2000 levels by 2010. This estimate is reflected below.[35]

Types(s) of GHG Benefit(s): This policy option would directly reduce HFC emissions. There is a possible rebound effect if substitute refrigerants are used and are less energy-efficient, which might increase CO2 emissions from electricity production.

Estimated GHG Savings and Costs per Ton:

Recent Actions (semi-conductor industry voluntary agreement)				
GHG Emission Savings		**0.22**	**0.22**	$MMtCO_2e$

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

[35] The state inventory and forecast for PFC emissions is based on the national USEPA projections, which assume a significant drop in emissions by 2010 and 2020 due to the industry voluntary agreement. Therefore these reductions are likely already included in the forecast; they are reported here for transparency and future reference.

RCI-10 Demand-Side Fuel Switching

Policy Description:

Reductions in greenhouse gas emissions can be achieved in the residential, commercial and industrial end-use sectors when consumers switch to the use of less carbon-intensive fuels to provide key energy services.

Policy Design:

Fuel switching opportunities can include using natural gas in the place of electricity for thermal end-uses, natural gas in the place of coal for key industrial end-uses, biomass fuels in the place of electricity or natural gas for thermal end-uses, and solar thermal energy in the place of electricity or natural gas for thermal end-uses.

The three following options are proposed:

- Phase I: Promotion of switching from high-carbon fuels to lower-carbon fuels (such as from oil or coal to natural gas).
- Phase II: Promotion of "low or zero carbon" fuels via incentives.[36]
    - The promotion of solar water heating through a combination of incentives and targeted research. These would build on incentives that already exist in the State.
    - The substitution of biodiesel for diesel in commercial and industrial equipment. Inventory estimates suggest that diesel/distillate fuel use in commercial and industrial sectors comprised 2-3% of the state's emissions in 2003 (2.3 million $MMTCO_{2e}$), thus the potential for emissions reductions could be quite significant.

Goals: Given the limited amount of coal use in the RCI sectors Arizona, and the site-specific issues (e.g. in cement production), goals for, and analysis of, switching among

[36] CCAG members have noted the importance of considering the cost of fuel-switching alternatives on a cost per ton of carbon savings basis, as well as the need to consider incentive structures that allow the users of alternate-fuel systems to pay back incentives over time so as to reduce the cost burden on society as a whole. CCAG members also noted that there could be a tradeoff between new incentives provided for the use of low/no-carbon fuels and current incentives effectively in place for fossil fuels, as well as tradeoffs between the costs of action to reduce greenhouse gas emissions and the costs of inaction.

fossil fuels (Phase I) have not yet been developed. For the Phase II options, in order to develop a rough quantification, the CCS team used some simple placeholders for the biofuels and solar water heating options. These should not be viewed as specific recommendations, but rather a way to gauge emissions impacts and to kick-start further discussions.

- **Biofuels.** There are at least two possible approaches here: a) biofuels are blended and supplied statewide as the standard filling station fuel (engine modifications unlikely to be required); b) pure biofuels (e.g. 100% biodiesel) are purchased directly by consumers and used in engines or other applications with technical modifications, if and as needed. To get an order of magnitude estimate of potential savings, we estimated emissions savings for a scenario in which biodiesel displaces 2% of diesel use by 2010 and rising to 20% by 2020.
- **Solar Water Heat.** For illustrative purposes we assume that solar water heaters could provide 70% of the energy needed in 5% of water heating applications (res/comm.) by 2010 and 25% of applications by 2020.

Implementation Method(s):

The following mechanisms could be implicated.

- Further tax or other financial incentives for solar water heating systems (see BAU policies).
- Targeted research at Arizona universities and research institutions to develop new and more cost-effective solar water heating technologies.
- Policies to promote the uptake of biofuels in commercial and industrial applications (See Transportation TWG)

Related Policies/Programs in Place:

- Arizona's Solar Energy Credit provides an individual taxpayer with a credit for installing a solar or wind energy device at the taxpayer's Arizona residence. The credit is allowed against the taxpayer's personal income tax in the amount of 25% of the cost of a solar or wind energy device, with a $1,000 maximum allowable limit, regardless of the number of energy devices installed.
- Arizona provides a sales tax exemption for the sale or installation of "solar energy devices". A solar energy retailer may exclude from tax up to $5,000 from the sale of each solar energy device, and a solar energy contractor may exclude up to $5,000 of income derived from a contract to provide and install a solar energy device.

Types(s) of GHG Benefit(s):

Solar water heating will avoid CO_2 emissions from displaced fuel use (e.g. gas) or electricity generation. Biofuels will avoid CO_2 emissions from diesel and gasoline combustion; however, lifecycle emissions from the production of biofuels need to be considered, and these could involve N_2O emissions from crop production. Other emissions impacts are likely to be relatively insignificant.

Estimated Illustrative GHG Savings and Costs per Ton:

Total for Policy			
GHG Emission Savings	**0.13**	**1.18**	MMtCO2e
Net Present Value (2006-2020)		not est.	$million
Cumulative Emissions Reductions (2006-2020)		7	MMtCO2e
Cost-Effectiveness		not est.	$/tCO2e
Other Key Results			
GHG Emission Savings from Solar Water Heating	0.09	0.71	MMtCO2e
GHG Emission Savings from Biodiesel	0.04	0.47	MMtCO2e

Discussion: This analysis reflects a very rough estimate of impacts as noted above. As a result, costs are not estimated.

Data Sources, Methods and Assumptions:

See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** Key data sources include Argonne National Laboratory (life cycle biofuel CO2e emissions), Lawrence Berkeley Laboratory and Public Service of New Mexico (to estimate electricity and gas used for water heating – no AZ data sources were found).
- **Quantification Methods:** The estimated emissions reductions are calculated in a straightforward manner based on multiplication of the various factors and assumptions noted here.
- **Key Assumptions:** See under "goals" above. It is assumed that most ethanol is provided from corn, and that by 2020, 20% of ethanol would be provided by cellulosic sources. Biodiesel is assumed to reduce the life-cycle GHG emissions of diesel by 78% on a tCO2e/Btu basis.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

- Potential local air pollution impacts (from switching from electricity to on-site fuels combustion, or from gas to other fuels)
- Potential local and state economic co-benefits [including rural employment] from using local biomass fuel supplies and installation of solar water heating systems.
- Biomass fuel supply/use may interact with land use, forestry, local air quality issues (from notes in the RCI TWG Policy Matrix).

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

RCI-11 Industrial Sector GHG Emissions Trading or Commitments

Note: This Option Is Moved to ES-4. During the May 16, 2006, CCAG meeting, it was agreed that further consideration of this option would be as part of Energy Supply option ES-4 (Cap and Trade Program). In Arizona, GHG emissions from power plants are likely to be over 10 times higher than emissions from industrial sources large enough to likely be included in a cap and trade program. Given that a common cap and trade program would likely apply to all sources (industrial and power supply), it was felt that the common discussions should occur within the ES group (with RCI participation).

Policy Description:

Industrial sector GHG emissions trading systems, with mandatory "caps" or voluntary emissions, are a means of limiting overall emissions while providing firms with choices as to how emissions limits will be achieved.

Policy Design:

Emissions cap and trade programs and/or voluntary emissions targets are options that have been considered for systematically addressing industrial sector GHG emissions. For example, a number of large industries (such as steel and cement) are included within the European emissions trading system, and have been proposed for inclusion in national legislation. Voluntary commitments have also been adopted within the US and internationally, exemplified by the US Climate Leaders program. This policy option specifically addresses how industrial sector sources would be addressed by trading systems and/or voluntary commitments.

The TWG suggests that an important first step would be to encourage the adoption of procedures to assist in the development of organizational GHG inventories, as would be enabled by a GHG registry.

RCI TWG members believe that emissions trading[37], in general, is a good idea. TWG

[37] Some TWG members feel that reference to emissions trading should explicitly include consideration of an emissions cap. There was not full TWG consensus on this matter. Some CCAG members also felt that a cap on emissions, possibly even at the State level, should be considered, perhaps in a phased manner, with a (combined RCI and ES) cap system put in place first for utilities, with industrial sector emitters covered by the program in a later phase, although another CCAG member suggested that if industries make significant progress in reducing emissions on their own, a cap for industries may not be needed.

members feel that a regional or national program approach would be preferable to a state level one. They feel that because the CCAG is a state-level advisory group, it may exceed the mandate of the CCAG to attempt development of a straw proposal; rather, an institution at a regional level or national level would best develop the concept and design elements. A recommendation for the CCAG to consider is a request that the governor explore a regional emissions trading program in a regional forum and/or advocate for development of national program.

RCI-12 Solid Waste Management

Policy Description:

This policy option considers several options to increase recycling and reduce waste generation in order to limit greenhouse gas emissions associated with landfill methane generation and with the production of raw materials.

Policy Design:

In 2005, over 3 million residents in 39 Arizona communities had access to residential curbside recycling, representing slightly over 50% of the state's population. To further increase the diversion of waste from landfill and the amount of materials recycled, the State should aim to:

- Ensure that curbside recycling programs are provided in all communities over 50,000 in population;
- Increase the penetration of recycling programs in multi-family dwellings;
- Create new recycling programs for the commercial sector;
- Increase average statewide participation/recovery rates for all existing recycling programs; and,
- Develop a statewide recycling goal.

Implementation Method(s):

Implementation options that should be considered include:

- **Expansion of ADEQ Waste Reduction Assistance (WRA) grants**. Grants can target projects that include new or expanded curbside recycling programs. Grants for new and expanded recycling programs to help overcome initial cost barriers faced by communities;[38]
- **Mandatory source separation and recycling laws or ordinances in urban areas.** Municipalities in several states require households or businesses to use recycling containers or services for targeted materials (e.g. office paper, home recyclables).[39] Some AZ solid waste experts feel that such measures may be needed if participation

[38] In 2006, four of the six awards were to communities for such projects.
[39] For instance, participants using standard waste containers for targeted items may be issued warning notices and/or fines for non-compliance.

rates are to be increased, and suggest starting with banning of landfill disposal of consumer electronics (a toxics hazard) to evaluate feasibility;

- **Tax breaks or other incentives** to make recycling financially attractive for private commercial sector waste haulers;
- **Full recycling as a contract requirement for state facilities**;
- **Government purchasing requirements for recycled content** of items purchased (paper, carpets, etc.);
- **Waste education campaign**, aiming at waste reuse and reduction, and targeting greenhouse gas reductions; and,
- **General awareness building**, e.g., working with community leaders to appreciate benefits and cost-effectiveness of curbside recycling.

Related Policies/Programs in Place:

See above.

Types(s) of GHG Benefit(s):

Waste prevention and recycling (including composting) divert organic wastes from landfills, thereby reducing the methane released when these materials decompose. Manufacturing goods from recycled materials typically requires less energy than producing goods from virgin materials. Waste reduction and reuse means less energy is needed to extract, transport, and process raw materials and to manufacture products.[40]

Estimated GHG Savings and Costs per Ton (for quantified actions):

Total for Policy			
GHG Emission Savings	**2.21**	**3.69**	MMtCO2e
Net Present Value (2006-2020)		not est.	$million
Cumulative Emissions Reductions (2006-2020)		36	MMtCO2e
Cost-Effectiveness		not est.	$/tCO2e

Note that about 15% of the above savings is estimated to be from avoided emissions from land filling (largely avoided methane release), and these savings should occur within the state. The other 85% is associated with avoided emissions related to the lower life cycle emissions of recycled compared with virgin products (wood harvesting, pulp and paper processing, transportation). To the extent that paper is manufactured outside the state, these emissions reductions will also occur outside the state.

Data Sources, Methods and Assumptions:

[40] Adapted from USEPA. See website for further details: http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ActionsWasteBasicInfoGeneral.html

- **Data Sources:** Key data sources include ADEQ (recycling amounts), USEPA studies (results from studies of life-cycle GHG emissions associated with managing waste materials)
- **Quantification Methods:** Assumes above efforts can increase amount of paper recycled by 600,000 short tons by 2010 and 1,000,000 short tons by 2020. Benefits from increased recovery of other materials not yet considered.
- **Key Assumptions:** Assumes national average landfill practices (methane recovery), transport distances, and waste composition (in a given category).

Key Uncertainties:

Key uncertainties are related to the feasibility and impact of the above recommendations.

Ancillary Benefits and Costs:

These could include:

- Reduction in environmental impacts related to disposal of wastes that are recycled and/or composted
- Income from sales of recycled materials, savings from avoided cost of landfill tipping fees
- Reduction of impacts related to manufacturing of new materials through recycling
- Local economic benefits from businesses engaged in recycling or reuse-related activities

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

RCI-13 Water Use and Wastewater Management

Policy Description:

A considerable amount of energy is used to pump, treat, and deliver water across the state. This policy options aims to reduce energy consumptions by reducing overall water use and improving the efficiency of water supply and wastewater facilities.

Policy Design:

The State currently uses about 7.7 million acre-feet (MAF) of water, 77% of which is delivered to agricultural consumers, 18% to municipal consumers, and the remainder to industrial users. A significant amount of energy is used to pump this water from underground aquifers (3.6 MAF), from the Colorado River (2.6 MAF), and other sources (1.2 MAF), and to treat it in wastewater facilities after it is used.[41] Five specific recommendations are provided below, along with an overall state water use reduction goal.

1. Accelerate investment in water use efficiency: Implement best management practices and efficient water management practices, and provide incentives for implementation of water management improvement measures. Coordinate with the investments in energy efficiency (RCI-1). Start in the areas of the state with most energy-intensive water use cycles. Consider developing a statewide water and wastewater savings plan, based on a thorough assessment of water and wastewater options in all water using sectors.
2. Increase the energy efficiency of all water and wastewater treatment operations. Develop long-term programs to better mesh with the long-term investments in water and wastewater infrastructure. For example, for water pumping, in particular, two specific options are worth considering:[42]
    - Pump Testing Program. A large amount of energy is likely expended by a small number of older well pumps that are often run until they failure, many years after it would be economic to replace them. Incentives combined with

[41] Other sources include the Salt and Gila Rivers. For a good description of the state's water sources and uses, see http://www.tceq.state.tx.us/assets/public/compliance/R15_Harlingen/US-MX%20BGC%20Water%20table%20documents/US%20States/Arizona/bgc_resources_and_issues_presentation_final.ppt

[42] Thanks go to Chico Hunter of SRP for valuable inputs on this option.

the provision of energy efficiency information through the existing DWR pump testing program could lead to significant energy savings.

- Encouraging Pump Design/Planning/Maintenance Best Practices Study in Rapidly Growing Areas. Many municipalities, especially small but rapidly growing cities, lack the experience or resources to optimize the specifications of new pumps to reduce energy consumption. An effort to benchmark effective pump specification, management, and maintenance procedures across municipalities and to share best practices with emerging cities could yield large savings.

3. Increase energy production by water and wastewater agencies from renewable sources such as in-conduit hydropower and biogas. Add generation from solar and wind resources to water and wastewater projects where applicable.
4. Encourage and create incentives for technologies with the capability to reduce water use associated with power generation. Included would-be zero- or low-water-use technologies and renewable energy technologies, as well as energy efficiency technologies that reduce electricity consumption.
5. Ensure that power plants use the best management practices and economically feasible technology available to conserve water (via siting, evaluation, permitting or other processes).

Implementation Method(s):

Specific implementation strategies are to be determined.

Related Policies/Programs in Place:

The AZ Department of Water Resources maintains a number of water management programs and policies.[43]

Types(s) of GHG Benefit(s):

GHG benefits (primarily CO_2) would result from avoided fuel and electricity consumption for pumping, treating, and delivering water.

Estimated GHG Savings and Costs per MTCO2e:

[43] See e.g., http://www.tceq.state.tx.us/assets/public/compliance/R15_Harlingen/US-MX%20BGC%20Water%20table%20documents/US%20States/Arizona/bcgwater_admin_overview.doc

Illustrative Estimates

Total for Policy			
GHG Emission Savings	**0.23**	**0.77**	MMtCO2e
Net Present Value (2006-2020)		not est.	$million
Cumulative Emissions Reductions (2006-2020)		6	MMtCO2e
Cost-Effectiveness		not est.	$/tCO2e

This analysis illustrates very roughly the magnitude of GHG savings that might result if state water use could be reduced by 10% compared with current usage levels by 2020 (i.e. by 0.8 MAF). Note that improvements in pump efficiency would provide GHG savings over and above this level; however, pump efficiency improvement potentials may already be partly taken into account in RCI-1 (for electric pumps only).

Data Sources, Methods and Assumptions:

See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. Sufficient information for cost-effectiveness assessment is not available. In summary:

- **Data Sources:** Arizona Department of Water Resources (water use levels) and California State Agencies (energy use and GHG emissions related to water use).
- **Quantification Methods:** The above estimate assumes a 10% water savings (relative to current levels) is achieved by 2020 (3% by 2010), and that 1 MtCO2e could be avoided for each MAF saved (based on CA estimates).
- **Key Assumptions:** The key assumption is that a 10% water savings is achievable by 2020.

Key Uncertainties:

Key uncertainties are related to the feasibility and impact of the above recommendations.

Ancillary Benefits and Costs:

These could include:

- The ancillary benefits and costs described for other energy efficiency options (see RCI-1)
- Reduced cost of electricity for water pumping displaced fuels costs for users of landfill gas and captured gas from waste treatment facilities.
- Central-station power plant cooling water savings
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes

Feasibility Issues, if applicable:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

Table 3.
Transportation and Land Use Technical Work Group
Summary List of Completed and Pending Policy Options

#	Policy Name	GHG Savings (MMtCO2e)	Cost-Effectiveness ($/tCO2e)	Status
TLU-1	California GHG Emission Standards	2010: 0.3 2020: 5.6	- $94.58	Completed
TLU-2 (and TLU-3)	Smart Growth Bundle of Options (incorporates previous TLU-3 Promoting Multimodal Transit)	2010: 0.6-3.2 2020: 0.7-4.0	Net Savings	Completed TLU-2; TLU-3 Pending
TLU-4	Reduction of Vehicle Idling	*Scenario 1* 2010: 0.3-0.5 2020: 0.5-0.7 *Scenario 2* 2010: 0.5-0.7 2020: 0.9-1.3	-$22 to -$42	Completed
TLU-5	Standards for Alternative Fuels	Not Quantified.	Not Quantified.	Completed
TLU-6	Fuel Tax	Not quantified	Not quantified	Pending
TLU-7	Hybrid Promotion and Incentives	2010: .003-.004 2020: .033-.048	Not Quantified.	Pending
TLU-8	Feebates	Not quantified	Not quantified	Pending
TLU-9	Pay-As-You-Drive Insurance	2010: ~0 2020: 2.8	Zero net cost	Pending
TLU-10	Low Rolling Resistance Tires	2010: n/a 2020: 0.8	Not Quantified.	Pending
TLU-11	Accelerated Replacement/ Retirement of High-emitting Diesel Fleet	Not Quantified.	Not Quantified.	Pending
TLU-12	Biodiesel Implementation	2010: 0.11 2020: 1.08	Not Quantified.	Pending
TLU-13	State Lead-By-Example (via Procurement and SmartWay)	Not quantified	Not quantified	Pending
TLU-14	60 mph Speed Limit for Commercial Trucks	Not Quantified.	Not Quantified.	Pending

TLU-1 California GHG Emission Standards

Policy Description:

Adopt the California GHG emission standards (also known as the "Pavley" standards or "Clean Car Program") in order to reduce the net emissions of GHG's from passenger vehicle operation.

Policy Design:

New cars and light trucks in all states must comply with Federal emission standards, and, generally speaking, states have the choice of adopting a stronger set of standards applicable in California. In 2005, California finalized a set of standards that would require reductions of GHG emissions of about 30 percent from new vehicles, phased in from 2009 to 2016, through a variety of means. The standards must still be approved by USEPA, and face a court challenge.

Implementation Method(s):

Standards take effect in Model Year 2011 (calendar year 2010)

Related Policies/Programs in Place:

Federal regulation of tailpipe emissions and fuel economy.

Types(s) of GHG Benefit(s):

Overwhelmingly CO2 reductions.

Estimated GHG Savings and Costs per MTCO2e:

	2010	2020	Units
GHG Emission Savings	0.3	5.6	MMtCO2e
Net Present Value (2006-2020)		-$2,944	$million
Cumulative Emissions Reductions (2006-2020)		31.1	MMtCO2e
Cost-Effectiveness		-94.58	$/tCO2e

Data Sources, Methods and Assumptions:

- **Data Sources:** Diane Brown and Elizabeth Ridlington, Cars and Global Warming: Policy Options to Reduce Arizona's Global Warming Pollution from Cars and Light Trucks, AZ PIRG Education Fund: February 2006, http://www.arizonapirg.org/AZ.asp?id2=22371 . CCS, Arizona Greenhouse Gas Inventory and Reference Case Projections, 1990-2020, March 2006.
- **Quantification Methods:** The AZ PIRG report used a model of light duty vehicle fleet comparing the difference between base case emissions and emissions with fleet penetration over time of vehicles that meet lower GHG emissions standards consistent with the California regulations. The AZ PIRG model calculated light duty vehicle fuel use and emissions based upon scientifically valid methods. (See extended discussion in AZ PIRG report, pp. 22-26).

  CCS compared the AZ PIRG model results to results for the New England states and California that were obtained using comparable modeling methods. CCS found that while all three modeling efforts were scientifically valid and comparable, some of the AZ PIRG model assumptions and methods were relatively conservative, while the California and New England modeling results were relatively optimistic. CCS further refined the AZ PIRG model results consistent with a middle range scenario that produced results less conservative than the AZ PIRG results and less optimistic than the California and New England results. While AZ PIRG projected a 13.7% reduction in light duty vehicle emissions with this policy, the CCS refinement estimates a 15.5% reduction in emissions. CCS applied this refined percentage reduction in emissions to the CCAG approved reference case scenario to obtain a net estimated reduction of 5.6 MMtCO2e in 2020.

This analysis assumes the program will start with the 2011 model year. Some 2011 model year vehicles will be on the market in calendar year 2010, and so there are some small emissions reductions that are foreseeable for that first year of sales/implementation.[44]

- **Key Assumptions:** The three modeling efforts have established a generally acceptable scientific method of projecting GHG emissions reductions from this policy. The CCS comparison of the three modeling methods provides some independent professional validation of the models and their results. The key assumption of the emissions reduction projected by CCS is that the most likely scenario for emissions reductions is one that would fall between the more conservative scenario projected by the AZ PIRG model and the more optimistic scenario projected by the California and the New England models.

Key Uncertainties:

[44] A CCS memo providing more details is available.

Fleet turnover rates for light duty vehicles and future patterns of consumer purchase choices between passenger cars and light duty trucks (i.e. SUVs).

Ancillary Benefits and Costs:

Some reduction in criteria pollutants is likely.

Feasibility Issues:

Light Duty Vehicle GHG emissions standards can be met with existing 'off-the-shelf' automotive technologies that are already in the marketplace.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

TLU-2 (and TLU-3) Smart Growth Bundle of Options

Policy Description:

This bundle of options encompasses four components related to reducing GHG emissions through land use practices and policies. These policies contribute to GHG emission reductions by reducing vehicle trips and total vehicle miles traveled.

Policy Design:

Smart growth actions include the following programs and program elements:

- **Infill and Brownfield redevelopment.** Shifting housing and commercial development toward location efficient sites, such as brownfields and infill projects, and away from location inefficient sites, such as greenfields, can reduce overall travel demand and expand lower emitting mode choices. Brownfields are commercial or industrial properties that are abandoned or are not being fully used because of actual or perceived environmental contamination. These properties have potential for redevelopment, but the uncertainty and risk of environmental liability and the cost of investigation and cleanup keep them from being redeveloped. Brownfields can be former industrial properties, abandoned gas stations, vacant warehouses, or former dry-cleaning establishments. Redevelopment of these environmentally contaminated properties creates jobs, revitalizes neighborhoods, increases property and sales tax revenues, decreases urban sprawl, and reduces potential health risks to the local community. Infill development can also revitalize neighborhoods, increase tax revenues, and decrease urban sprawl.
- **Transit-oriented development (including multi modal transit proposals previously covered under option TLU-3)** includes a shift to lower emitting mode choices by building compact development around transit stops to meet daily needs by foot, bicycle, or transit and/or by clustering employment centers around transit stops.
- **Smart growth planning,** modeling, and tools includes a number of practices aimed at encouraging location efficient growth in communities that are proximate to household amenities (such as jobs, shopping, school, services, entertainment, etc.) as opposed to growth in areas that are not proximate and require greater travel distance and have less mode choice. Smart growth allows for mixed land uses within a project with a range of housing opportunities and multiple transportation options including pedestrian/bike access.

- **Targeted open space protection** includes programs designed to protect and conserve State lands and other open spaces, and develop and improve neighborhood, community, and regional parks in ways that encourage location efficient growth and broader mode choice.
- **Promote multimodal transit (including multi modal transit proposals previously covered under option TLU-3)** and promote shifts in passenger transportation mode choice (auto, bus, rail, bike, pedestrian, etc.) to lower emitting choices, and includes: make optimal use of CMAQ funds; expand transit infrastructure (rail, bus, BRT); improve transit service, promotion, and marketing (including tax-free Commuter Benefits); improve bike and pedestrian infrastructure; explore commuter rail using existing rail corridors; consider re-establishing train service between Phoenix and Tucson; review all proposed transportation projects for multi-modal flexibility (e.g., add BRT or light rail if feasible); conduct research into new transportation technologies and urban planning techniques.

Goal levels: Target a reduction in growth in VMT from passenger vehicles of 2%-11% in the years 2007-2020 through a combined approach utilizing a number of programs that fall under those listed above.

Implementation Method(s):

Specific policy measures would include:

- Promote use of authority under Growing Smarter/Plus by counties to impose development fees consistent with municipal development fee statutes.
- Promote smart growth principles in new development by requiring bidders to include defined smart growth principles in bid packages.
- Promote use of authority under Growing Smarter/Plus by cities to create infill incentive districts and plans that could include expedited process incentives.
- Promote use by cities of a fee waiver system, similar to Phoenix Infill Housing Program, to encourage development of single-family owner-occupied housing on vacant, orphaned, or underutilized land located in the mature portions of Arizona.
- Provide technical assistance to communities that want to pursue Smart Growth and disseminate lessons learned in cities such as Phoenix and Tucson.
- Provide Smart Growth information tools that identify the qualitative (e.g., improved quality of living) and quantitative benefits (e.g., reduced vehicle operation costs) of these Smart Growth communities.
- Encourage lenders to apply location-efficient mortgage principles, so transportation cost savings is recognized when calculating a household's borrowing ability.

- Encourage cities to review (and update where appropriate) their engineering plans and standards to make new road and sidewalk infrastructure friendlier to bikes and pedestrians.
- Promote telecommuting.[45]
- Promote affordable housing in new developments.
- Carefully review land swaps that lead to undesirable development patterns.
- Implement the vision set forth in the MoveAZ report.

Related Policies/Programs in Place:

For many years, Arizona and various counties and cities have pursued a variety of policies related to Smart Growth (e.g., Growing Smarter legislation and actions by Phoenix and Tucson). In addition, in 2004, the Arizona Department of Transportation completed a long-range transportation plan for the state entitled MoveAZ (www.moveaz.org). Adopted by the State Transportation Board, MoveAZ provides policy directions, performance-based evaluations of capital transportation projects, and tools for ADOT to use in planning and implementing a vibrant multi-modal transportation system for the state. If successful, these efforts will complement the other actions in the Smart Growth bundle and help it achieve VMT reductions more toward the upper range of estimates for that option.

Types(s) of GHG Benefit(s):

CO2 reductions

Estimated GHG Savings and Costs Per MTCO2e:

	2010	2020	Units
GHG Emission Savings (2% case) (11% case)	0.6 3.2	0.7 4.0	MMtCO2e
Net Present Value (2006-2020)		Net savings	$ million
Cumulative Emissions Reductions (2006-2020)		Not quanitfied	MMtCO2e
Cost-Effectiveness		Net savings	$/tCO2e

[45] There was also a suggestion of Hybrid access to HOV lanes, but this will go elsewhere, not part of Smart Growth

Data Sources, Methods and Assumptions:

- **Data Sources:** CCS, Arizona Greenhouse Gas Inventory and Reference Case Projections, 1990-2020, March 2006. Extensive Smart Growth literature.
- **Quantification Methods:** Modified AZ reference cast forecast for 2008-2020 using 2% - 11% reduction in VMT.
- **Key Assumptions:** The value used for reduction in VMT. Also assumes de minimus increases in GHG emissions from increased use of alternate transit modes. Assumes that infrastructure savings offset other costs.

Key Uncertainties:

Sensitivity of VMT growth to policy shifts.

Ancillary Benefits and Costs:

Reduced infrastructure costs, avoided health care costs via reduced air pollution and increased walking/biking, other quality-of-life aspects. However, there will be front-end costs of program development and implementation for brownfields, infill, and transit-oriented development programs. A successful program requires dedicated resources to ensure redevelopment is achieved. There are grants available from the EPA that assist with the initial establishment of a program or to fund environmental activities for a specific project; however, successful local and state brownfields programs have a dedicated source of funds for the program. Financial resources are required to fund staff (at least one full-time employee is typical), administrative expenses, promotion, education, etc. on an annual basis, which has averaged approximately $200,000 per year for the City of Phoenix.

Many successful programs have used financial incentives to jump-start private sector investment. As the market increasingly embraces Smart Growth, these may become less necessary. Most federal brownfields programs are not available directly to the private sector; therefore, the most effective programs nationwide provide local or state financial assistance. In the City of Phoenix, capital improvement bond funds are used to provide financial assistance directly to the private sector and to encourage the use of brownfields for public facilities. Phoenix secured $3.4 million from the 2000 Phoenix Bond Program and recently obtained $4 million from the 2006 program for brownfields redevelopment.

Feasibility Issues:

Smart Growth developments sell at a premium.

Status of Group Approval:

Completed for TLU-2, Pending for Multi Modal Transit incorporated from TLU-3

Level of Group Support:

Unanimous for TLU-2

Barriers to Consensus:

None cited for TLU-2

TLU-4 Reduction of Vehicle Idling

Policy Description:

Reduce idling from diesel and gasoline heavy-duty vehicles, buses, and other vehicles through the combination of a Statewide anti-idling ordinance and by promoting and expanding the use of technologies that reduce heavy-duty vehicle idling, including: automatic engine shut down/start up system controls; direct fired heaters (for providing heat only); auxiliary power units; and truck stop electrification.

Policy Design:

Currently, only Maricopa County has an anti-idling ordinance. This ordinance has not been enforced due to a lack of enforcement funding and enforcement authority. This policy would build off of the Maricopa County ordinance, strengthen it, and make it applicable statewide by the end of 2008. The statewide ordinance should be designed to be easily enforceable by the appropriate state and local agencies. It is critical that a dedicated state-funding stream for enforcement is needed for this measure to be successful in reducing vehicle idling and the resulting reductions in GHG emissions. The ordinance would also need to limit exemptions as much as possible, to make it easier to enforce. However, idling that occurs for public health and safety reasons (such as emergency vehicles) should be exempted from this rule.

This measure will also reduce idling from heavy-duty vehicles through programs aimed at increasing voluntary adoption of idle reduction technologies. ADEQ and the county agencies would collaborate on outreach and education beginning in the year 2008, to coincide with the implementation and enforcement of a statewide anti-idling ordinance. The State would also seek funding for pilot projects and demonstrations from CMAQ (Congestion Mitigation Air Quality) funds, as well as funds available through EPA, DOE, and DOT. These pilot programs could be used to evaluate the effectiveness of various idle reduction technologies prior to more widespread use throughout the state. Pilot projects could include truck stop electrification as well as an expanded school bus pilot program. The outreach materials should emphasize the benefits of reducing idling, including a reduction in fuel costs, GHG emissions, and toxic emissions.

- **Goal levels: Implement** a statewide vehicle idling restriction ordinance that can be enforced and that minimizes allowable exemptions, and provide the necessary resources for enforcing the ordinance. Develop and pilot truck stop electrification programs. Scenario 1: Target an overall reduction in idling of 50% by year 2010. Scenario 2: Target an overall reduction in idling of 80% by 2010 and 100% by 2020.

- **Timing:** Have ordinance in place by 2008.
- **Parties:** Industry, ADEQ, Counties, school districts, truck stop owners

Implementation methods:

Information and education: Provide general public, trucking industry, and bus companies with information indicating when and where idling is prohibited, and under what circumstances it is permitted. Indicate the benefits of reducing idling, including fuel savings, toxic emission reductions, and GHG reduction. Provide a hotline number to call to report violations. Encourage trucking companies to do their own policing of measure. Also reach out to busing companies, school districts, and truck stop owners to make bus and truck drivers aware of idling restrictions. Ensure that signs are also posted in venues associated with bus idling (e.g., sporting events, shows, etc.). Emphasize the fuel savings benefits, reductions in toxic emissions, and reduced engine wear associated with reducing idling.

Provide information to fleet carriers, shippers, retailers, bus companies, school districts, and others involved in the diesel fleet industry indicating the economic benefits, as well as the environmental benefits, of applying idle reduction technologies. Also, identifying best practices within the industry and recognizing companies with these best practices in place within Arizona should be used to encourage companies to select these carriers for their shipments. Develop outreach materials with cost benefits information and toxic diesel health impacts. Outreach materials should also be geared toward making the general public aware of the GHG, toxics, and fuel-saving benefits of eliminating idling on personal vehicles, as well as on trucks and buses. Expand school bus idling program based upon the pilots currently being conducted.

Technical assistance: Coordinate with anti-idling product manufacturers to organize workshops/outreach programs to regulated community to let them know of technological options that provide alternatives to the need for idling including products for cabin comfort, power for other functions (e.g., refrigerated trucks), and engine warm-up.

Funding mechanisms and or incentives: Propose legislation to partially fund idling technology loan grants for truck stop electrification and other idle reduction technologies in the State, focusing grants on high idling areas. Determine a dedicated funding stream that can be used to fund enforcement of anti-idling ordinance as well as for continued education and outreach. Funding the enforcing agency with an adequate share of the revenue from using the idling reduction facilities could be an option. CMAQ funds and federal money may be available for idle reduction programs. A plan needs to be developed to apply for the funds.

Voluntary and or negotiated agreements: Work with regulated entities to promote voluntary compliance assistance through distribution of materials, staff training, etc. Encourage participation in EPA's SmartWay Transport Partnership (or similar programs).

Codes and standards: Include proper language in ordinance so that the agency with enforcement responsibilities is clearly delineated and has full authority to enforce the ordinance. The language of the statewide ordinance should also make enforcement straightforward (e.g., such that any exemptions to the idling policy can be easily observed). In developing the statewide anti-idling ordinance, EPA's recent Model State Idling Law should be reviewed for potential ordinance language. For example, the EPA model rule contains the following language exempting vehicles used for emergency and public safety purposes: "A police, fire, ambulance, public safety, military, other emergency or law enforcement vehicle, or any vehicle being used in an emergency capacity, idles while in an emergency or training mode, and not for the convenience of the operator."

Pilots and demos: Coordinate with product developers to help them promote their technologies. Investigate availability of funds for pilot or demo projects on idle reduction technologies from EPA, DOE, and DOT. If funding is available, develop a pilot program to evaluate the effectiveness of various idle reduction technologies, including implementation of truck stop electrification and expanded school bus idling program. Evaluate the effectiveness of the pilot programs before implementing on a broader scale.

Reporting: Develop a system for tracking violations so that the State can eventually determine compliance rates and benefits achieved from the ordinance.

Enforcement: Phase enforcement program to initially conduct outreach (Phase 1), provide warnings for a limited period of time (Phase 2), then issuance of tickets (Phase 3).

Related Policies/Programs in Place:

Idling restrictions are currently in place in Maricopa County. House Bill 2538, (2001 regular session) requires counties containing portions of Area A[46] to implement and enforce ordinances limiting maximum idling time for Heavy Duty Diesel Vehicles weighing over 14,000 pounds gross vehicle weight rating (GVWR). Other counties in Arizona also have the option of adopting an ordinance. The Maricopa County ordinance states "No owner or operator of a vehicle shall permit the engine of such vehicle to idle for more than five (5) consecutive minutes except as provided in Section 4 (Exemptions) of this ordinance." Violators are subject to a civil penalty of $100 for the first violation and $300 for a second or any subsequent violation, and can be enforced by any law enforcement officer on private/public property. Truck stop/distribution center owners/operators are required to erect signs indicating the maximum idling time in Maricopa County is 5 minutes. Exemptions are allowed under a number of conditions. To date, however, no violators of this ordinance have been fined. (Maricopa County Ordinance can be found at http://www.maricopa.gov/aq/rules/docs/fin-VIRO.pdf)

ADEQ School Bus Idling program. A number of school districts are participating with ADEQ in their School Bus Idling Pilot project. Key elements of this project include having drivers turn off buses upon reaching a school or other location and not turn on the engine until the vehicle is ready to depart; parking buses at least 100 feet from a school

[46] See www.azdeq.gov/environ/air/vei/images/areaa.html.

air intake system; and posting appropriate signage advising drivers to limit idling near the school. This program could be expanded throughout the state.

Idle reduction programs are currently being used by some shippers/carriers/retailers in Arizona. As an example, Swift Transportation is a charter member of EPA's SmartWay Transport program. This company maintains a modern fleet with an average vehicle age of less than 3 years old. Idle strategies used include optimized idle and other technologies as well as driver training.

Types(s) of GHG Benefit(s):

Reducing idling will reduce black carbon emissions, as well as all other GHG exhaust emissions (CO2, CH4, N2O) through reduced fuel consumption. However, it is important to also ensure that any technologies used to reduce idling have lower emissions than the diesel truck idling emissions they are replacing.

Estimated GHG Savings and Costs per MTCO2e:

	2010	2020	Units
GHG Emission Savings (Scenario 1) (Scenario 2)	0.3-05 0.5-0.7	0.5-0.7 0.9-1.3	MMtCO2e
Net Present Value (2006-2020) (Scenario 1) (Scenario 2)	-143 to 192 -258 to 341		$million
Cumulative Emissions Reductions (2006-2020)	(Scenario 1) 4.5-6.5 (Scenario 2) 8.3-11.8	MMtCO2e	
Cost-Effectiveness (Scenario 1) (Scenario 2)		-$22 to $42 -$22 to $41	$/tCO2e

Data Sources, Methods and Assumptions:

- **Data Sources:**

- American Transportation Research Institute, "Idle Reduction Technology: Fleet Preferences Survey," February 2006 for technology costs.
- EPA SmartWay Transportation Partnership (http://www.epa.gov/otaq/smartway/idlingtechnologies.htm#truck-mobile) for technology costs.
- "Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks," ANL/ESD-43, Argonne National Laboratory, Transportation Technology R&D Center, June 2000 for information on technology impacts.
- Data from EPA's MOBILE6 model were used to estimate the proportion of CO2 emissions attributable to Class 8 trucks.
- Data from USDOE/EIA *Annual Energy Outlook 2005* were used to estimate the amount of fuel consumed annually per truck.
- "Model State Idling Law," EPA420-S-06-001, U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Transportation and Regional Programs Division, March 2006.

- **Quantification Methods:**
  - The estimated reduction in CO2 emissions from reduced idling was calculated based on estimating the portion of emissions and fuel consumption in the AZ inventory that were attributable to Class 8 diesel trucks, estimating the portion of the total fuel consumption that would be consumed during idling, and applying a targeted reduction of 50 or 80 percent to this amount starting in 2008 and a reduction of 50 or 100 percent starting in 2015.
- **Key Assumptions:**
  - This analysis assumes idle reductions are achieved only by Class 8 diesel truck population; these trucks idle for an average of 6 hours per day; they consume 0.8 to 1.2 gallons of diesel per hour during idling; and that a 50, 80 or 100 percent reduction of diesel idling from these Class 8 trucks is achieved.
  - The cost analysis assumes a 5-year lifetime for idling technology equipment, applied to 50 or 80 percent of Class 8 vehicles starting in 2008 and 80 or 100 percent of Class 8 vehicles starting in 2015, at a cost of $6,000 per vehicle and a $2.40 per gallon diesel cost.
  - Program administration costs, enforcement costs, and fines have not been factored into the cost analysis. Reduced vehicle maintenance costs have not been factored into the analysis.

Key Uncertainties:

Buses, as well as other diesel trucks and gasoline vehicles and trucks that have not been quantified here could achieve a small additional reduction in idling emissions. The distribution of technology that would be selected by these trucks or fleets to reduce their emissions is highly uncertain. This will have a significant impact on the overall cost/cost savings of this measure. The use of these technologies will also cause a slight decrease in the CO2 and fuel consumption reductions achieved. The use of truck stop electrification would increase emissions from electricity generation. Equipment cost and lifetime will vary by technology employed. The cost value selected was based on cost data summarized by American Transportation Research Institute, representing the capital costs of a variety of idle reduction technology. The cost of $6,000 per vehicle represents a mix of higher and lower technology costs. The cost analysis does not take into account the number of vehicles that have already installed idle reduction technologies.

Ancillary Benefits and Costs:

Reductions in idling will also reduce emissions of toxics, NOx, and PM. California estimates that 70 percent of toxic risk comes from diesel engines.

Idle emission reductions will reduce fuel consumption, thus leading to a cost benefit from reduced operating costs.

Additional costs are associated with on-board idle reduction technologies, but fuel savings over time typically lead to a net savings.

Providing idling reduction technologies (electrification/portable power units) at mandatory truck stops, such as Port-of-Entries/weigh stations, could prevent idling in other locations throughout the State. Providing central warehousing infrastructure may avoid idling required for refrigeration or other critical needs. However, providing any new infrastructure requires funding.

Feasibility Issues, if applicable:

Ability to enforce remains critical.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

TLU-5 Standards for Alternative Fuels

Policy Description:

Develop and enforce standards for ethanol, biodiesel, and other alternative fuels in order to ensure fuel quality and reduce performance problems with these fuels, and to enable more widespread acceptance of these fuels.

Policy Design:

Develop and enforce a state standard for neat biodiesel (B100), biodiesel blends, and ethanol blends. For biodiesel blends, the biofuel portion and the petroleum diesel portions of the fuel are separately regulated through ASTM standards; however, no standard is currently in place for the blended biodiesel. Similarly, for ethanol blends, E85 and the gasoline portion of ethanol blends are regulated by ASTM standards.

Arizona currently has legislation pending that would also regulate the ethanol portion of ethanol blends. This measure is intended to support that legislation and provide a backup provision if the legislation does not pass. The base gasoline for ethanol blends must meet the standards for gasoline sold in that area. Enforcement of the standard should be designed to ensure that fuel taxes are being paid and that blenders are registered with the State. To reduce fraud, the measure should ensure fuel that is delivered is as advertised, and eliminate consumer problems. Enforcement of this standard would be led by the Arizona Department of Weights and Measures. Certain exemptions might be acceptable (e.g., a school district blending biodiesel for use in its own school buses and not for outside sale).

These standards should be in place by the end of 2008. Increased funding and resources are needed for enforcement of this measure. Through the National Energy Act, growth in alternative fuels is expected in the near term. This measure will ensure that these alternative fuels sold in Arizona meet quality standards. This measure would also be broadened to include other alternative fuels that may be sold in Arizona.

- **Goal levels:** ASTM D5798-99 as the standards for E85.
  ASTM D6751 as the standard for biodiesel.
- **Timing:** Standards should be in place by the end of 2008 to encourage the use of biofuels within the State.
- **Parties:** AZDWM, ADOT, ADEQ, local jurisdictions, school districts

Implementation Method(s):

Information and education: Information and education will be used to disseminate information to industry and public

Codes and standards: Support the provisions of HB2590: HB2590 is the E85 bill. The current bill does several things. First it adopts ASTM D5798-99 as the standards for E85. It sets standards for the equipment that will be dispensing E85 to ensure compatibility with the corrosive nature of E85. It establishes reporting requirements that will track product quality and amount of E85 produced. Finally, it requires that the gasoline portion of the E85 must be Cleaner Burning Gasoline in the CBG Covered Area. This is a consistent approach with how EPA deals with E85 in RFG areas. Recommend that EVR at retail be required for E-85 (or parallel to approach CARB is currently investigating). (Note: this bill was enacted by the State Legislature in April 2006.)

Currently under A.R.S. 41-2083(K) through (N), the Department of Weights and Measures regulates the quality of biodiesel. The current law requires that biodiesel must meet the specifications in ASTM D6751 and that the diesel portion of the biodiesel must meet ASTM D975. This should help protect the consumer. Again, as in the proposed legislation, the current law requires reporting to track volumes and help ensure the quality of the product.

Enforcement: Increased funding and resources for enforcement. Currently, the Department, under A.R.S. 41-266, has the authority to enter a facility, take samples, seize evidence, and take product off sale if it is found not to conform to State standards. State inspectors currently inspect fueling facilities throughout the state and check fuel quality and compliance with our regulations. These powers and duties are also codified in the department rules under R20-2-104. These rules will need to be clarified to indicate where the standards will be enforced and the fines that will be levied for violations.

Related Policies/Programs in Place:

National requirements for increased use of biofuels.

Types(s) of GHG Benefit(s):

Reduced CO2 emissions.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

Reduced criteria pollutants, but could increase NOx.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

TLU-6 Gas Tax

Policy Description

A tax on gasoline could provide a source of revenues for investment in efficient and low emitting transportation systems that reduce emissions related to passenger vehicles.

Policy Design

A small increase in the gasoline tax could fund low-GHG travel options. With consumption of approximately 95 million barrels per year of gasoline and diesel in 2010, each one-cent increase in the state fuel tax would raise about $40 million. This amount would increase in 2020 to $52 million.

Implementation method:

Activity Tax

Related Policies/Programs in Place:

Existing fuel tax.

Types(s) of GHG Benefit(s):

CO2, black carbon

Estimated GHG Savings and Costs Per MTCO2e:

Not quantified.

Data Sources, Methods and Assumptions:

Not quantified.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

Some reduction in criteria pollutants.

Feasibility Issues:

The group noted significant political barriers to increased gasoline taxes.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-7 Hybrid Promotion and Incentives

Policy Description:

A combination of public education and information and financial incentives to promote the sales of light duty vehicles with hybrid gasoline-electric power trains.

Policy Design:

- **Goal levels:** An increase of 1% in the hybrid share of the light duty vehicle fleet for the period 2008-2020.
- **Timing:** 2008-2020
- **Parties:** Industry**,** ADEQ, Arizona Department of Revenue

Implementation Methods:

Hybrid promotion and incentive programs would be implemented from the years 2007 through 2020. This covers the time period between the near term years when production is limited and the medium-to-long term years when expansion of production capabilities makes it more likely that promotion and incentive policies will have a significant effect on consumer choices. Some promotion programs could include public education and information and partnership programs. Some incentive programs could include financial incentives such as reduction in fees and taxes for owners of newly purchased hybrid vehicles or giving preferential infrastructure access to hybrids on carpool lanes or metered parking spaces. [IMPORTANT:] The state needs to study further the level and design of incentives necessary to achieve the goal set forth here.

In the near term (2006-2008), the hybrid vehicle sales are constrained on the producer side by an inability of automobile manufacturers to keep up with already existing consumer demand. In the medium-to-long term (2009 forward for Arizona), automobile manufacturers are likely to increase production capabilities for hybrid power train vehicles, and provide consumers with many more choices of hybrid cars. As a result, hybrid promotion and incentive programs are likely to have some incremental positive net effect on consumer purchase behavior.

Related Policies/Programs in Place:

Current law provides for a Federal income tax credit up to $3400 for purchase of a hybrids.

Estimated GHG Savings and Costs Per MTCO2e:

	2010	2020	Units
GHG Emission Savings	0.003-0.004	0.033-0.048	MMtCO2e
Net Present Value (2006-2020)		Not quantified	$million
Cumulative Emissions Reductions (2006-2020)		Not quantified	MMtCO2e
Cost-Effectiveness		Not quantified	$/tCO2e

Data Sources, Methods and Assumptions:

The United States Department of Energy's (USDOE) Oak Ridge National Laboratory (ORNL) projected that total hybrid sales could range from 700,000 to 1.1 million units in 2008 and 1.7 million to 2.5 million units in 2012. CCS estimated that hybrid promotion and incentive programs would be responsible for 1% of total sales that would not have resulted without the programs. CCS also assumed that new light duty vehicle sales in Arizona would continue to be about 2% of total nationwide sales. Given average mileage of Arizona light duty vehicles and the difference in miles per gallon between the hybrid vehicles and conventional gasoline power train vehicles, CCS calculated the estimated amount of gallon savings and resulting reduction in GHG emissions.

The CCS analysis assumes that total automobile sales and manufacturer production plans will be consistent with those assumed in the Oak Ridge National Laboratory study. The quantification analysis assumes that LDV GHG emissions standards consistent with TLU-1 are <u>not</u> in place with model year 2011. The analysis also assumes that the annual mileage for Arizona automobiles stays constant at an average of 13,000 miles, and that hybrid powertrain cars provide a 12.5% to 40% improvement on MPG than comparable conventional cars. In general, the sets of assumptions and methods used would tend to produce a relatively conservative estimate of greenhouse emission reductions.

Key Uncertainties:

There are numerous uncertainties about what influences consumer demand for different types of automobiles. While some consumer education and incentive programs have been shown to have positive impact (e.g. most notably, Energy Star programs), the degree of success of hybrid vehicle promotion and incentive programs is uncertain.

Ancillary Benefits and Costs, if applicable:

None cited.

Feasibility Issues, if applicable:

None cited.

Status of Group Approval:

TBD

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-8 Feebates

Policy Description:

"Multi-State LDV GHG Fee and Rebate Study and Pilot Program." The State of Arizona would participate in funding a multi-state study of "feebate" program benefits and costs, including the neighboring states of California and New Mexico. Feebate proposals usually have two parts--(1) a fee on relatively high emissions/lower fuel economy vehicles and (2) a rebate or tax credit on low emissions/higher fuel economy vehicles.

Policy Design:

The "Multi-State LDV GHG Fee and Rebate Study and Pilot Program" would consider the expected impacts of individual state feebate programs as well as coordinated or consistent multi-state programs. Ideally, such a multi-state study would include a number of western states in order to assess boundary issues and well as coordination issues. Initial analysis suggests that the Arizona new car market, which represents approximately 2% of the United States market, may be too small a share of the market to have an effect on the types of vehicles that manufacturers put into the marketplace. A consistent set of feebate programs across multiple states may include a large enough share of the US market to have a more significant effect on supply side decisions made by automobile manufacturers. The study would also identify and assess the actual benefits and costs of a pilot feebate program to be implemented at the county or metropolitan level in the western United States.

Economic analyses of these proposals have found that feebate programs would work on two levels. First, the feebates would directly affect consumer choices for vehicle purchases as a result of the financial incentives. Second, the feebates could indirectly affect the types of vehicles that automobile manufacturers choose to put into the marketplace.

While feebate proposals have been described in academic studies, there has been no implementation of a full feebate program to date in the United States. While there are individual 'gas guzzler tax' and tax incentives for hybrid vehicle purchases, there is not yet any history of an 'on-the-ground' example of a comprehensively implemented feebate program.

Both the United States Department of Energy and the Canadian Transport Ministry have studied the potential impacts of national level feebate programs in recent years. While these studies have informed the debate about the advantages and disadvantages of national feebate programs, there remains considerable uncertainty about the potential benefits and costs of state or multi-state level feebate programs.

There is an important need for a greater understanding of the potential effects of single state or multi-state feebate programs on the types of vehicles that manufacturers put into the marketplace. Since existing analysis shows that 90% of the benefits of feebate programs are likely to arise from the manufacturing (supply side) response rather than the consumer (demand side) response, it is important to develop a better understanding of where the threshold for manufacturer response lies and the degree of impact of single state and multi-state programs. Some political issues also may arise relating to the potential perception of the fee portion of these programs as additional taxes on motor vehicles.

Implementation Method:

The State of Arizona would fund a cost-shared study with other western states. The study would be jointly funded and administered by the environment agencies and energy agencies of the states that choose to cooperate in this study.

Related Policies/Programs in Place:

None cited.

Estimated GHG Savings and Costs Per MTCO2e:

Not quantified.

Data Sources, Methods and Assumptions:

CCS conducted a review of the most relevant research and analysis on feebate proposals. CCS made three findings:

(1) There has been significant conceptual development of the feebate idea, especially at the national level.

(2) There is a need for a greater understanding of potential benefits and costs of state level and multi-state coordinated feebate programs.

(3) There has not been sufficient pilot testing of feebate programs in the United States to provide implementation experience.

CCS assessed recent studies of potential GHG emission reductions from a national feebate program based on modeling work conducted by the US Department of Energy's Oak Ridge National Laboratory (ORNL). CCS also reviewed other relevant recent studies and analyses of feebates conducted by the Canadian government, the State of California, and PIRG. The ORNL and other studies assume a national feebate rate high enough to produce responses from both consumers and manufacturers. The ORNL's estimate of the national potential for reduction in carbon dioxide emissions is approximately 11 MMTCO2e in 2010 and 66 MMTCO2e in 2020.

Some attempts have recently been made to estimate the GHG emissions reduction potential from individual state feebate programs, including programs proposed for the states of Arizona and California. For example, a recent PIRG analysis suggests that a single state feebate program for Arizona would result in an estimated 0.1 MMtCO2e

GHG emissions reductions in 2020. These recent estimates of the potential impacts of individual state programs are contingent upon assumptions and analytical methods that have not undergone thorough peer review. Therefore, the results of these analyses are preliminary and should be interpreted with some caution. Further analysis and study of the potential benefits and costs of individual state and multi-state feebate programs would greatly increase confidence in projected results.

Key Uncertainties:

The results of a feebate program depend on manufacturer and consumer response, which are uncertain at this time.

Ancillary Benefits and Costs, if applicable:

Feebates would reduce criteria pollutants along with GHG emissions.

Feasibility Issues, if applicable:

Requires multi-state cooperation.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-9 Pay-As-You-Drive Insurance

Policy Description:

Pay-As-You-Drive (PAYD) insurance program (changing part of vehicle insurance payments from fixed charges to per-mile charges).

Policy Design:

Arizona would change insurance regulations to allow PAYD insurance; and initiate and promote an aggressive pilot of PAYD in 2008. Assuming this Pilot is successful, market penetration could increase to 100% by 2020. This could happen either through competitive pressure (increasing numbers of companies offer it in order to stay competitive) or through a change in state policy mandating PAYD at some point after it has been shown to work.

Pay as You Drive Insurance has been promoted by a variety of groups for reasons that include emissions reduction and safety (through decreased driving), and fairness (by changing insurance costs to more closely track the portion of individuals' risk that is created by miles driven). Some key questions and answers are presented below.

Q: Would PAYD penalize rural residents because they drive further than average?
A: Rates can be set—as most insurance rates are—for classes. PAYD rates would be charged within classes, so that a driver in that class (say, "rural") traveling the average distance would pay the same under PAYD as before.

Q: Does the technology exist to support PAYD?
A: Yes. The necessary equipment for remote mileage readings is standard on GM OnStar-equipped vehicles. Add-on equipment to relay mileage automatically has been added in several pilot projects for several hundred dollars. All MY1996 vehicles and newer have OBD (on-board diagnostics) that already electronically monitor mileage that can be quickly downloaded via transponder. And current odometers are tamper-proof enough to support yearly mileage readings with no additional technology.

Q: Is there any on-the-ground experience with PAYD?
A. Yes. Several companies around the world offer PAYD today. In English-speaking countries:

1) Progressive Insurance ran an initial 5,000-car pilot in Texas, which saw reductions in driving of ~20%. A subsequent pilot in Minnesota filled up its 4,800 spots quickly, and Progressive is now rolling it out in other states. https://tripsense.progressive.com/

2) GMAC Insurance and OnStar have announced a PAYD program.

3) The British insurance company Norwich Union offers PAYD in Britain. (http://www.norwichunion.com/pay-as-you-drive/index.htm).

4) North Central Texas Council of Governments and King County Metro (Seattle) have both recently concluded Requests for Proposals to conduct PAYD pilots (http://www.nctcog.org/trans/air/programs/payd/index.asp). No available results yet.

Any of these pilots could be useful sources of models for an Arizona pilot project.[47] See also the discussion in the AZ PIRG report (pp. 25-26).

Implementation Method(s):

Authorization and pilot project, followed by evaluation and promotion.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

CO_2 reductions.

Estimated GHG Savings and Costs Per MTCO2e:

	2010	2020	Units
GHG Emission Savings	~0	2.8	MMtCO2e
Net Present Value (2006-2020)		No net cost	$million
Cumulative Emissions Reductions (2006-2020)		Not quantified	MMtCO2e
Cost-Effectiveness		No net cost	$/tCO2e

[47] For additional information see: Kevin Maney, "For a price, would you let car insurer along for the ride?", *USA Today*, 8/3/05. http://www.usatoday.com/money/industries/technology/maney/2005-08-03-car-monitoring_x.htm ;Todd Litman, "Pay-As-You-Drive Vehicle Insurance: Converting Vehicle Insurance Premiums Into Use-Based Charges" http://www.vtpi.org/tdm/tdm79.htm; Dean Baker, "Insurance By the Mile", *Harper's Magazine*, June, 2006. http://harpers.org/bb-insurance-by-the-mile-2838238.html ; Ian W.H. Parry, "Is Pay-As-You-Drive Insurance: a Better Way to Reduce Gasoline than Gasoline Taxes?," Resources for the Future (www.rff.org/Documents/RFF-DP-05-15.pdf), 2005.

Data Sources, Methods and Assumptions:

CCS examined an Arizona PIRG report and compared its model results for estimated reductions in vehicle miles of travel with other studies of PAYD policies, including those produced by the Economic Policy Institute and Resources for the Future (RFF). Arizona PIRG conducted an analysis of the potential GHG reductions from a Pay-As-You-Drive (PAYD) automobile insurance policy. CCS found that the AZ PIRG estimates were comparable with other estimates, which ranged from 8 percent to 20 percent. As a result, the Arizona PIRG results for estimated reductions in vehicle miles of travel and greenhouse gas emissions reductions fell within the lower range of the comparable estimates. That is, the emissions reduction estimates are conservative.

AZ PIRG's analysis assumed that insurers are required to offer mileage-based insurance for certain elements of vehicle insurance, including collision and liability. AZ PIRG assumes the PAYD policy is required, phased in over time, and that all drivers in Arizona are eventually covered. (That is, AZ PIRG's analysis assumes a different path to 100% penetration than does CCS, but both assume that penetration reaches 100% by 2020.)

To calculate GHG savings, Arizona PIRG converted Arizona state automobile collision and liability insurance expenditures to an insurance cost per mile (6.4 cents per mile). Assuming insurance consumers pay 80 percent of their collision and liability insurance on a per-mile basis, drivers would be assessed about a 5.1-cent charge per mile. This per-mile insurance charge would reduce vehicle-miles traveled by about 8 percent, and light-duty vehicle carbon dioxide emissions by about 4 percent. (See AZ PIRG, "A Blueprint for Action," pp. 25-26) To put this charge in context, at 20 mpg, 5.1 cents/mile = ~$1/gallon of gasoline.

Key Uncertainties:

The specifics of the PAYD insurance programs are to be determined, and the actual effects of PAYD insurance on driver behavior are subject to some significant uncertainty.

Ancillary Benefits and Costs, if applicable:

Reductions in criteria air pollutants, reductions in crashes.

Feasibility Issues, if applicable:

The CCAG raised questions and potential concerns regarding disproportionate impacts on rural drivers.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-10 Low Rolling Resistance Tires

Policy Description:

Improve the fuel economy of the light duty vehicle (LDV) fleet by setting minimum energy efficiency standards for replacement tires and requiring that greater information about Low-Rolling Resistance (LRR) replacement tires be made available to consumers at the point of sale.

Policy Design:

- **Goal levels:** Require that replacement tires be LRR tires achieving an average 3% gain in fuel economy.
- **Timing:** The requirement would begin in 2008.
- **Parties:** Industry**,** AZDWM, ADOT, ADEQ

Implementation Method:

Manufacturers currently use LRR tires on new vehicles, but they are not easily available to consumers as replacement tires. When installing original equipment tires, carmakers use low rolling resistance tires as a way to contribute to meeting the federal automobile fuel economy (CAFÉ) standards. When replacing the original tires, consumers often purchase less efficient tires. Currently, tire manufacturers and retailers are not required to provide information about the fuel efficiency of replacement tires. In addition, there is no current minimum standard for fuel efficiency that all replacement tires must meet. The rolling resistance of the various tires consumers can purchase have significant variations depending on tread design, composition, cross-section geometry, and inflation pressure.

The program would include consideration of the technical feasibility and cost of such a program, the relationship between tire fuel efficiency and tire safety, potential effects upon tire life, and impacts on the potential for tire recycling. In addition, the program would exempt certain classes of tires that sell in low volumes, including specialty and high performance tires.

An appropriate State agency would initiate a fuel efficient tire replacement program. The program could include consumer education, product labeling, and minimum standards elements. These programs would be developed under a rule development process that would incorporate the best scientific information, including the results from tests of tires conducted by the tire manufacturers, the California Energy Commission, and other data reviewed by the National Academy of Sciences.

The minimum standard is likely to be less stringent than the energy efficiency of original tires provided by the automobile manufacturers on new purchase vehicles. Such a regulation would improve the fuel efficiency of the overall LDV fleet, but not necessarily the fuel efficiency of all tires since consumers would still make choices in the marketplace. The replacement tires in the future would be on average more fuel efficient than those historically purchased, but are likely to be on average not as fuel efficient as the tires included as original equipment by the automobile manufacturers.

Related Policies/Programs in Place:

In October of 2003, California adopted the world's first fuel-efficient replacement tire law. AB 844 is a "first-of-its-kind" law requiring energy efficient tires. AB 844 directed the California Energy Commission (CEC) to develop a State Efficient Tire Program. Specifically, AB 844 requires the CEC to: (1) develop a consumer education program, (2) require that retailers provide labeling information to consumers at the point of sale, and (3) promulgate through a rule development process a minimum standard for the fuel efficiency of replacement tires sold. The California rule development process is scheduled to begin in January 2007.

Estimated GHG Savings and Costs Per MTCO2e:

	2010	2020	Units
GHG Emission Savings	~0	0.8	MMtCO2e
Net Present Value (2006-2020)		Not quantified	$million
Cumulative Emissions Reductions (2006-2020)		Not quantified	MMtCO2e
Cost-Effectiveness		Not quantified	$/tCO2e

Data Sources, Methods and Assumptions:

- **Data Sources:** Studies by National Research Council, California Energy Commission, and Arizona PIRG
- **Quantification Methods:** CCS evaluated and compared a series of existing assessment, as follows:

At the request of the United States Congress, the National Research Council of the National Academy of Sciences (NRC/NAS) conducted a study of the feasibility of reducing rolling resistance in replacement tires. The 2006 NRC/NAS study made the following conclusions:

“Reducing the average rolling resistance of replacement tires by a magnitude of 10 percent is technically and economically feasible.

Tires and their rolling resistance characteristics can have a meaningful effect on vehicle fuel economy and consumption.

Although traction may be affected by modifying a tire’s tread to reduce rolling resistance, the safety consequences are probably undetectable.

Reducing the average rolling resistance of replacement tires promises fuel savings to consumers that exceed associated tire purchase costs, as long as tire wears life is not shortened.”

A 2003 study commissioned by the California Energy Commission found that about 300 million gallons of gasoline per year can be saved in that state with lower rolling resistance tires. A set of four low rolling resistance tires would cost consumers an estimated \$5 to \$12 more than conventional replacement tires. The efficient tires would reduce gasoline consumption by 1.5 to 4.5 percent, saving the typical driver \$50 to \$150 over the 50,000-mile life of the tires. Consumers would save more than \$470 million annually at current retail prices or approximately \$1.4 billion over the three-year lifetime of a typical set of replacement tires.

The Arizona PIRG report, “A Blueprint for Action,” presents estimates for potential carbon dioxide emission reductions from a low-rolling resistance replacement tire program. The AZ PIRG estimate for GHG reductions from a fuel efficient tire program is 0.7 MMTCO2e in 2020. PIRG calculates an estimated 2.4 percent reduction in greenhouse gas emissions from the PIRG-calculated baseline. (See AZ PIRG, “A Blueprint for Action,” pp. 22-23, 54)

The PIRG analysis uses a base case scenario that is different from the approved Arizona CCAG reference case scenario. As a result, the CCS quantification method used was to apply the 2.4 percent estimate of the emissions reductions to the CCAG reference case scenario, producing an emissions reduction that is higher than the 0.7 MMtCO2e estimated by AZ PIRG. The resulting CCS estimate for emissions reductions from fuel-efficient replacement tires is 0.8 MMtCO2e in 2020.

- **Key Assumptions:** The amount of greenhouse gas emissions reductions from this policy depends upon what the average fuel efficiency of replacement tires would be under such a policy and the rate at which consumers will replace their existing tires with more fuel-efficient tires.

Key Uncertainties:

The low rolling resistance fuel efficient tires program is based upon existing off-the-shelf technologies and products that already exist in the consumer marketplace. These tires are already available in the marketplace, and are comparable with the tires included as original equipment on new purchase light duty vehicles.

Ancillary Benefits and Costs:

Some reduction in criteria pollutants.

Feasibility Issues:

Some members of the group raised questions about potential safety and performance compared to conventional tires.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-11 Accelerated Replacement/Retirement of High-emitting Diesel Fleet

Policy Description:

Reduce GHG black carbon emissions from heavy-duty diesel vehicles by developing and implementing an incentives program in Arizona to accelerate the replacement and/or retirement of the highest-emitting diesel vehicles.

Policy Design:

Starting with the 2007 model year, the emission standards for new heavy-duty diesel vehicles will be significantly tightened. In conjunction with these more stringent emission standards, the sulfur content of diesel fuel will be lowered from 500 parts per million (ppm) to 15 ppm. These measures will combine to significantly reduce GHG black carbon emissions from heavy-duty diesel trucks and buses. However, a large number of older, more-polluting diesel vehicles will remain in the fleet. This measure is aimed at determining methods to incentivize the owners of these older vehicles to retire their vehicles early and replace them with vehicles meeting the 2007 emission standards.

- **Goal levels:** Assuming the model years eligible for diesel retrofits also make the most sense for accelerated retirement (e.g., they still have over 4 years of expected useful life and are not meeting the 2007 emission standards), a likely/reasonable scenario would be to target 25 percent of these eligible vehicles for replacement.
- **Parties:** Industry**,** ADEQ, local jurisdictions, school districts

Implementation Method(s):

Information and education: An information and education component will be needed to provide truck and bus owners, school districts, and municipal organizations with information regarding the significant GHG black carbon emission reductions that could be achieved by retiring certain truck or bus engines with high annual emissions and replacing them with vehicles meeting the new emission standards. Provide information on potential funding partners, grants, or loans available from a number of organizations for this purpose.

Tools: Develop a database tool to show the lifetime emission reductions that would be achieved from retiring specific truck and bus models as well as calculator to estimate the cost of purchasing a new vehicle on an accelerated schedule.

Funding mechanisms or incentives: Develop policies to incentivize truck and bus owners with high annual emissions to retire their vehicles on an accelerated basis.

Voluntary and or negotiated agreements: The program could be set up on a strictly voluntary basis.

State lead by example: The State of Arizona could lead by example by replacing their older/dirtier vehicles. Target fleet owners of older vehicles within the State for a pilot program aimed at replacing a number of that fleet's vehicles.

Related Policies/Programs in Place:

None cited.

Estimated GHG Savings and Costs Per MTCO2e:

Reductions are estimated at 0.09 to 0.18 MMtCO2e in 2010.

Data Sources, Methods and Assumptions:

- **Data Sources:** CCS, Arizona Greenhouse Gas Inventory and Reference Case Projections, 1990-2020, March 2006.
- **Quantification Methods:** Spreadsheet analysis using vehicle fleet size, assumptions on turnover and replacement, and emissions factors to calculate black carbon reductions.Assuming the model years eligible for diesel retrofits also make the most sense for accelerated retirement (e.g., they still have over 4 years of expected useful life and are not meeting the 2007 emission standards), the maximum reduction from replacing all of these eligible diesel trucks would be 0.34 to 0.73 MMtCO2e in 2010. A more likely/reasonable scenario would be to target 25 percent of these eligible vehicles for replacement. This would give a reduction of 0.09 to 0.18 MMtCO2e in 2010.
- **Key Assumptions:** A replacement rate of 25 percent.

Key Uncertainties:

Actual attainable replacement rates.

Types(s) of GHG Benefit(s):

This program will reduce black carbon emissions.

Ancillary Benefits and Costs, if applicable:

This program will also reduce emissions of PM, NOx, and toxics.

Feasibility Issues, if applicable:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-12 Biodiesel Implementation

Policy Description:

Increase market penetration of biodiesel fuels in Arizona by a mixture policies (voluntary and/or mandatory) to achieve feasible goals.

Policy Design:

Increase market penetration of biodiesel fuels in Arizona. (Ethanol reductions are presented under TLU-5.) Conduct a review of any technical impediments to biodiesel use, and, if these are not significant, proceed to policies and measures that significantly increase biodiesel use and substitution for conventional diesel fuel. Target programs to the best possible applications where they are most likely to be successful and with a certainty of obtaining significant GHG emission reductions. This measure will help to ensure that Arizona is actively pursuing and meeting or exceeding the alternative fuel penetration goals specified in this Act.

- **Goal levels:** 75% B2 penetration by 2010. Review the program success by 2015, considering the interactions of biodiesel blends with the ultra-low sulfur diesel to be sold nationally by 2010 and the implementation of new diesel vehicle emission standards starting in 2007, and determine whether further penetration of biodiesel fuel is desirable. If the program is determined to be successful at that point and supply of biodiesel is not an issue, set a goal of at 50% B20 penetration by 2020.
- **Timing:** See above.
- **Parties:** Industry**,** AZDWM, ADOT, ADEQ, local jurisdictions, school districts

Implementation Method(s):

Increased market penetration of biodiesel could, potentially, be implemented by a variety of means, including:

Information and education: An information and education component will be needed to let consumers know of product availability and associated performance issues, as well as the potential benefits of using these fuels.

Voluntary and or negotiated agreements: A program could be set up on a voluntary basis and target certain fleet segments. For example, a B20 biodiesel program (20% biodiesel blended with 80% petroleum diesel) in a truck fleet with older vehicles (e.g., without diesel particulate filters) should achieve success. Emergency vehicles and snow removal vehicles should not be included in such programs.

Codes and standards: In order for this program to be successful, the standards and enforcement recommended under policy TLU-5 (Standards for Alternative Fuels) should be in place first. The state could impose a mandatory biodiesel use requirement for fuel vendors, that goes beyond that the biofuels requirement in the Energy Security Act of 2005.

Pilots and demos: Have State of Arizona lead by example. Where practical, have State diesel vehicles begin using B10 and B20 fuel and report on experience to industry.

Related Policies/Programs in place:

HR 6, the Energy Security Act of 2005, established a Renewable Fuel Standard that requires that 4 billion gallons of ethanol and/or biodiesel be used in 2006 and increasing to at least 7.5 billion gallons in 2012.

Types(s) of GHG Benefit(s):

This measure will reduce emissions of CO2 by 78 percent when compared to CO2 emissions from diesel fuel on a full life cycle basis.

Estimated GHG Savings and Costs Per MTCO2e:

	2010	2020	Units
GHG Emission Savings	0.11	1.08	MMtCO2e
Net Present Value (2006-2020)		Not quantified	$million
Cumulative Emissions Reductions (2006-2020)		8.8-17.5	MMtCO2e
Cost-Effectiveness		Not quantified	$/tCO2e

Data Sources, Methods and Assumptions:

- **Data Sources: "**Final Arizona Greenhouse Gas Inventory and Reference Case Projections 1990-2020," The Center for Climate Strategies, June 2005. "Documentation of Inputs to Macroeconomic Assessment of the Climate Action Team Report to the Governor and Legislature," California Climate Action Team, January 2006. *A Life Cycle Inventory of Biodiesel and Pertoleum Diesel for Use in an Urban Bus,* Sheehan et al. May 1998.
- **Quantification Methods:** The quantity of diesel fuel projected to be used in Arizona in the AZ GHG inventory were multiplied by the penetration rate of biodiesel fuel

(0.02*0.75 for 2010, 0.20*0.5 for 2020). Emission reductions from this option were quantified based on multiplying the biodiesel fuel penetration by a CO_2 emission factor of 1.03*10-8 MMtCO2/gal and then applying a 78% reduction in CO_2 to account for the biodiesel CO_2 reduction. (Sheehan, et al, May 1998).

- **Key Assumptions:** This analysis assumes a 78% reduction in CO_2 emissions from biodiesel fuel and resolution of barriers to market penetration.

Key Uncertainties:

GHG benefits will depend on biodiesel feedstock and production process used. Benefits may differ for older trucks versus those meeting 2007 emission standards. The effect of biodiesel on engines meeting new pollution standards with low sulfur diesel is questioned by some in the industry.

Ancillary Benefits and Costs, if applicable:

The use of biodiesel will also reduce emissions of PM, SO_2, CO, and HC in older vehicles (emission reduction potential reduced with new technology engines equipped with catalysts and diesel particulate filters). EPA has reported that the use B20 biodiesel can lead to a 21% reduction in HC, 11% reduction in CO, and a 10% reduction in PM. Toxic emission reductions can also be significant. However, biodiesel can lead to increased exhaust emissions of NOx and some air toxics, depending on feedstock and blend level. EPA reports a 2% increase in NOx emissions for B20 blends. Effects on newer diesel vehicles are likely to be different. An increased penetration of biofuels reduces our foreign fossil fuel dependency. Biodiesel reduces energy content which reduces fuel economy: 0.9-2.1% reduction for B20 and 4.6-10.6% reduction for B100. Biodiesel typically costs more than diesel (EPA estimates a 30 to 40 cents per gallon increase.)

Feasibility Issues, if applicable:

Some members of the group were concerned that biodiesel use could lead to operational problems, particularly at low temperatures, and could also lead to operational problems on new technology engines equipped with diesel particulate filters. Others felt that these issues have been resolved and would not impact future biodiesel use.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-13 State Lead-By-Example (Procurement and SmartWay)

Policy Description:

Arizona state agencies "could lead by example" by enacting procurement policies and or joining the EPA SmartWay program that result in adoption of lower emitting vehicle fleets. There are three primary components of the program: creating partnerships, reducing all unnecessary engine idling, and increasing the efficiency and use of rail and intermodal operations.

Policy Design:

Goals, levels, timing and participation in procurement or voluntary standards programs were not specifically considered, and need to be developed in the future.

Implementation Method(s):

There are numerous activities Arizona could pursue to participate fully in enacting procurement policies or programs such as SmartWay. For example:

State agencies with vehicle fleets could sign on as SmartWay carrier partners. They would then measure their environmental performance with the FLEET model and come up with a plan to improve that performance. The partnership provides information and suggested strategies to improve fuel economy and environmental performance of vehicle fleets.

State agencies that buy transportation services, or ship goods could sign on as SmartWay shippers. As shipper partners, state agencies would seek to select SmartWay partners when they purchased the services of carriers. One way that the state could help would be to add SmartWay certification to the list of factors that they may consider when selecting carriers. Alternatively, they could just encourage the carriers that they do business with to join the partnership. Shippers can also implement direct strategies, for instance developing no-idle policies for their loading areas.

State agencies could sign onto SmartWay as affiliates. As affiliates, they would help to distribute information on the program to interested parties. This could be as easy as putting a link on their web site, or it could involve a more active role.

Related Policies/Programs in Place:

There are three Arizona based carriers in the program now: Knight Transportation, Inc., McKelvey Trucking Company, and Swift Transportation Co.

Types(s) of GHG Benefit(s):

CO_2, black carbon

Estimated GHG Savings and Costs Per MTCO2e:

Not quantified

Data Sources, Methods and Assumptions:

Not applicable

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

Some reduction in criteria pollutants.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

TLU-14 60 MPH Speed Limit for Commercial Trucks

Policy Description:

Reduce speed limit for commercial trucks to 60 mph.

Policy Design:

Goals, levels, timing and participation in revised speed limit policies were not specifically considered, and need to be developed in the future.

Implementation Method(s):

Regulatory standard combined with information and education.

Related Policies/Programs in Place:

Current speed limits are as high as 75 mph, depending on the highway segment.

Types(s) of GHG Benefit(s):

CO_2, black carbon

Estimated GHG Savings and Costs Per MTCO2e:

Not quantified.

Data Sources, Methods and Assumptions:

Not quantified.

Key Uncertainties:

Ability to enforce a speed limit significantly lower than current policy.

Ancillary Benefits and Costs:

Some reduction in criteria pollutants.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

Table 4.
Agriculture and Forestry Technical Work Group
Summary List of Completed and Pending Policy Options

#	Policy Name	GHG Savings ($MMtCO_2e$)	Cost Effectiveness ($\$/tCO_2e$)	Status
	FORESTRY			
F-1	Forestland Protection from Developed Uses	2010: 0.3 2020: 0.3	$17	Completed
F-2	Reforestation/Restoration of Forestland	2010: 0.02 2020: 0.2	$283	Completed
F-3a	Forest Ecosystem Management – Residential Lands	2010: 0.5 2020: 0.5	-$21	Completed
F-3b	Forest Ecosystem Management – Other Lands	2010: 0.2 2020: 0.2	-$21	Completed
F-4	Improved Commercialization of Biomass Gasification and Combined Cycle	Not Quantified[a]	Not Quantified[a]	Completed
	AGRICULTURE			
A-1a	Manure Management – Manure Digesters	2010: 0.1 2020: 0.4	$7 (Dairies only)	Completed
A-1b	Manure Management – Land Application	Not Quantified[b]	Not Quantified[b]	Pending
A-2	Biomass Feedstocks for Electricity or Steam/Direct Heat	2010: 0.05 2020: 0.1	-$8	Completed
A-3	Ethanol Production	2010: 0.5 2020: 0.6	$150	Completed
A-4	Change Feedstocks (optimize for CH4 and/or N_2O reduction)	2010: 0.03 2020: 0.07	$165	Pending
A-6	Grazing Management	Not Quantified[b]	Not Quantified[b]	Pending
A-7	Convert Land to Grassland or	Not	Not	Completed

	Forest	Quantified[b]	Quantified[b]	
A-8	Agricultural Land Protection from Developed Uses	2010: 0.08 2020: 0.2	$65	Pending
A-9	Programs to Support Local Farming/Buy Local	2010: 0.003 2020: 0.01	Not quantified	Completed
[a] Not quantified due to overlap of biomass energy resource with Option F3a and F3b. [b] Not quantified due to uncertainty in the potential GHG reduction benefits. [d] Additional work needed to determine if the elements of this policy can be incorporated into existing programs.				

NOTES:

Policy overlaps: GHG reductions associated with biomass energy utilization from biomass supply quantified from options F3a and F3b will overlap with GHG reductions achieved by commercializing biomass gasification/combined cycle technology in option F4 (since the biomass energy from F3a and b will serve as input to F4). Therefore, GHG reductions have been quantified under F3a and b only.

F-1 Forestland Protection from Developed Uses

Policy Description:

Reduce the rate at which existing forestlands and forest cover are cleared and converted to developed uses or damaged by development that reduces productivity.

Policy Design:

- **Goal levels:** Given the considerable carbon storage potential of forest and woodlands in Arizona, and the trend of loss of these vegetation types in the past two decades, we propose that policy initiatives decrease the conversion of forest and woodlands to urban and other developed uses to 50 percent or less of the rates of loss to these uses during the 1987-1997 period by 2010 and continuing through 2020.
- **Timing:** see discussion above
- **Parties:** County governments, Arizona Department of Environmental Quality, private non-profit land trusts. Forest protection accomplished through acquisition of conservation easements and fee title by public and private conservation organizations.
- **Other:**

Implementation Method(s):

Information and Education; Technical Assistance; Funding Mechanisms; Voluntary/Negotiated Agreements.

Related Policies/Programs in Place:

None identified.

Types(s) of GHG Benefit(s):

- CO2: Carbon savings occur when live carbon stocks (trees, shrubs, and some soil organic carbon) are protected from clearing and the associated decay or combustion of cleared biomass. Carbon losses are offset to some extent by the portion of harvested biomass that is converted to durable wood products (carbon storage in product use), and for that portion converted to renewable energy and displaces fossil energy use that otherwise would be used. Because conversion of forestland to developed land uses typically is permanent, replacement biomass does not grow back on the site to offset removals of live biomass (i.e., to the levels that existed during forest use).

- CH4: New research indicates that about four percent of the carbon storage benefits of live forests are offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.
- Black Carbon: Emissions of black carbon (soot) result from combustion of biomass from open burning during land clearing, but the heating effect is likely to be offset by the large amount of organic material that is also emitted during biomass combustion.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 0.31 MMtCO2e/yr reduced in 2010 and 2020.
- Net Cost per $MtCO_2e$: $17

Data Sources, Methods and Assumptions:

- **Data Sources:** The number of acres that moved from forested land and rangeland to developed uses between 1982 and 1997 was obtained from the USDA Natural Resource Inventory (NRI). Based on comparison of rangeland acreage from NRI and pinyon-juniper acreage from USDA Forest Service, it was determined that roughly 38% of rangeland is pinyon-juniper. For the purposes of this analysis, pinyon-juniper is considered forested land. Forest carbon stock per acre data values were calculated from 2003 USDA Forest Service carbon stock and acreage data.[48] Cost data for conservation easements on forested lands was obtained from the New Mexico Forest Legacy Program and the Nature Conservancy.[49] [50]
- **Quantification Methods:** The annual rate of loss from the NRI data was determined to be 7,400 acres/yr (combined forest and rangeland based on loss rates from 1982-1997). The rangeland acreage was adjusted to reflect the amount of pinyon-juniper forest on these lands (38% of rangeland in the NRI was estimated to be pinyon-juniper forest). Reducing the loss rate by 50% yields 3,700 acres/yr protected. Assumptions regarding carbon losses due to development are: for each acre lost to development, 10,000 sq ft (0.23 acre) looses 100% of soil carbon; the remainder of that acre loses 25% of soil carbon; 90% of above ground carbon is lost. The number of acres saved per year was multiplied by the loss of carbon on these acres to estimated carbon savings. Carbon savings were then converted to CO2e.

[48] Jim Smith, USDA Forest Service, personal communication with S. Roe, CCS.
[49] Bob Sivinski, NM Forest Legacy Program, and personal communication with H. Lindquist, CCS, June 2006.
[50] Bob Findling, The Nature Conservancy, and personal communication with H. Lindquist, CCS, June 2006.

Costs were estimated as the midpoint of the high and low costs for identified conservation easements on forested lands in the southwest. The low cost was $720/acre for an easement; the high cost was $3,200 ($4,000/acre appraised land value and assuming 80% of land value for easement).

- **Key Assumptions:** Some rangeland carbon estimates are not currently included in forest carbon estimates due to data limitations; however, "Nonstocked" and "Pinyon-Juniper" forest stands as defined by FIA include many lands classified as "Rangeland" by NRI. Forecasted carbon stock measurements from 2002 to 2020 are based on extrapolations of past trends from 1982-1997 and assume a static continuation of all land cover and land use dynamics during that period. Implementation mechanisms are assumed to be "growth neutral" to avoid offsetting development impacts, i.e. land protection does not result in land clearing in other areas (also referred to as "leakage"). Cost savings from avoided land clearing costs may be contingent on regulatory acceptance of alternative land development approaches, such as conservation design or cluster development.

Key Uncertainties:

- Benefits: The rate at which live biomass stocks would have declined beyond business as usual due to forest health and forest fire risks may be significant. The rate of offsetting development effects from land protection may be sensitive to the design of policy implementation tools.
- Costs: Regulatory acceptance of alternative development approaches by local governing bodies may affect potential cost savings of avoided land clearing costs.

Ancillary Benefits and Costs:

- Protection of working lands for sustainable wood products use, recreation, and cultural and natural heritage.
- Environmental asset protection, including watersheds, wildlife and air quality.
- Reduced costs of infrastructure and services for dispersed or low-density development.
- Reduced transportation emissions from increased location efficiency.
- Certain biomass combustion technologies may result in significant air pollution.

Feasibility Issues:

None identified.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

F-2 Reforestation/Restoration of Forestland

Policy Description:

Expand forest cover (and associated carbon stocks) by regenerating or establishing forests in areas with little or no forest cover at present.

Policy Design:

- **Goal levels:** 430,000 acres of forestland impacted by wildfire restored to stocking rates of 47 tons of above ground biomass per acre (on average depending on forest type). Explore potential for additional benefits in restoring forests impacted by insect damage.
- **Timing:** 430,000 acres of forestland regenerated/established from 2008-2020, including approximately 70,000 acres regenerated/established by 2010 and 360,000 acres between 2010 and 2020. Average of 33,000 acres/yr.
- **Parties:** USFS, AZ Forestry Division, Universities, City/County Governments, Private Industry.

Implementation Method(s):

- *Research and Development* – need to identify forest areas that are best suited for restoration efforts; additional research needed to identify the potential for restoring areas impacted by insects/disease; Funding *Mechanisms* - Additional work needed to identify funding sources.

Related Policies/Programs in Place:

None identified.

Types(s) of GHG Benefit(s):

- CO2: Carbon savings occur when forest carbon stocks (trees, shrubs, and soil organic carbon) are established and sustained above and beyond existing levels.
- CH4: New research indicates that about four percent of the carbon storage benefits of live forests are offset by methane release.

Estimated GHG Savings and Costs per MTCO2e:

- GHG reduction potential in 2010, 2020: 0.02 MMtCO2e/yr in 2010; 0.23 MMtCO2e/yr in 2020.
- Net Cost per $MtCO_2e$: \$376 in 2010; \$283 in 2020.

Data Sources, Methods and Assumptions:

- Data Sources: See footnotes to Option F1 for common references used to estimate carbon densities on AZ forestlands [carbon stocks and above ground carbon densities are derived from the Forest Inventory Analysis (FIA) volumetric measurements conducted on a five-year cycle by the USFS]. Acres burned in AZ between from 2000 – 2005 were obtained from USFS[51]. The total acres burned were used as the basis for the acreage to be reforested. A map of these areas is provided below.
- Quantification Methods: Reforestation of 5% of the burned areas was assumed for the 2008 – 2010 period. Another 25% of the burned areas were assumed to be reforested within the 2010 – 2020 time frame. The amount of carbon to be sequestered on these lands was determined using the average aboveground carbon stocking for AZ forestlands based on the AZ Inventory & Forecast. The length of time for each restored stand to reach maturity was assumed to be 50 years. It was further assumed that without restoration, it would take 100 years for each stand to reach maturity. Cost data for reforestation projects were taken from a survey conducted by the Interstate Compact Mining Commission (relative to restoring coal mining lands).[52] These data suggest reforestation costs could range from $50 to $250 per acre. Due to the relative lack of AZ-specific data and the years represented by the cost data, the high end of this range was used to provide a conservative estimate of program costs.
- Key Assumptions: Rates of forest regeneration (i.e. 2% annual biomass replacement in restored areas; 1% annual replacement without restoration). Feasibility of reforestation – reforestation of some forest types might not be technically feasible. For example, ponderosa pine forests could be difficult to restore, especially with current levels of precipitation.

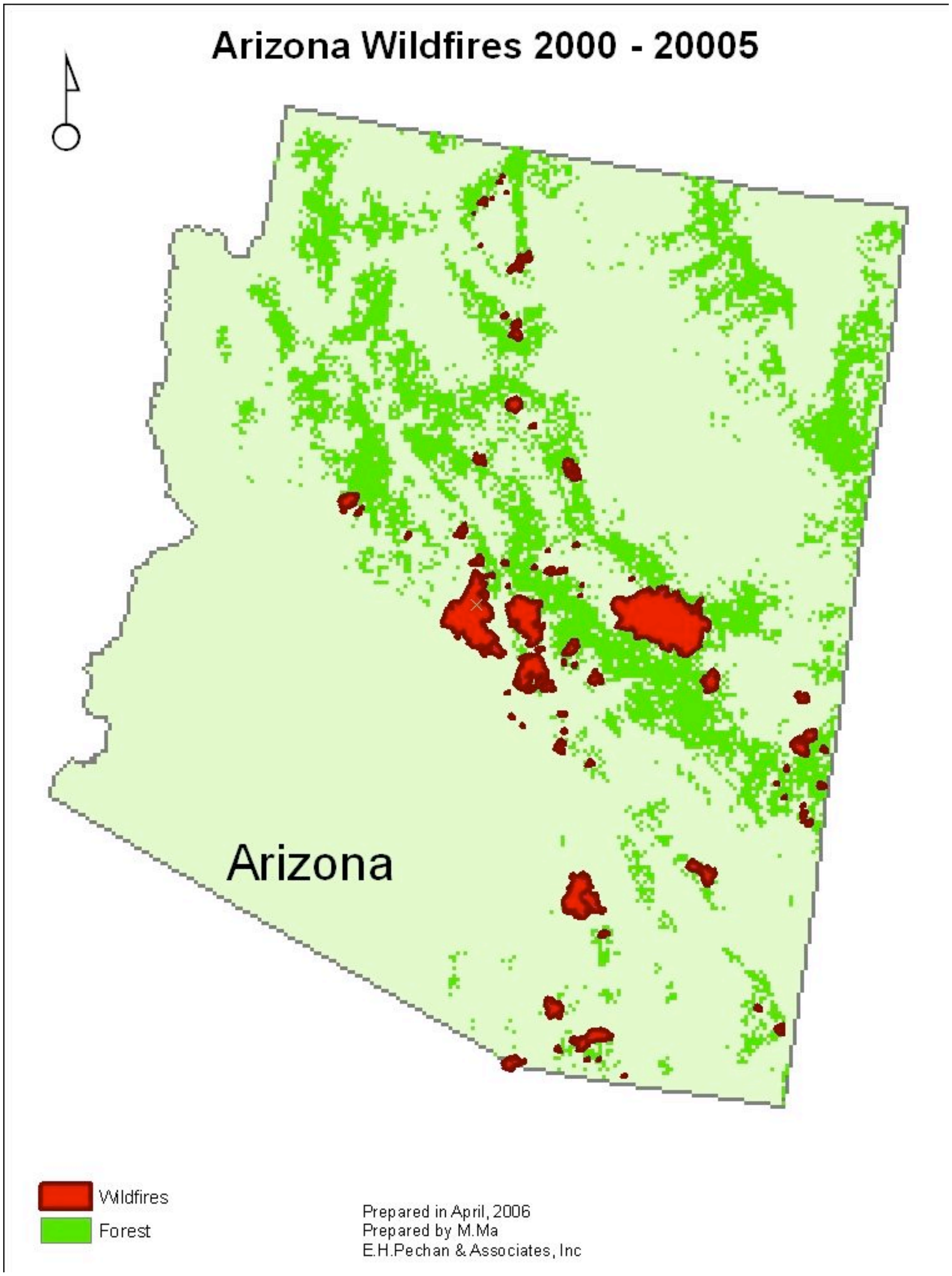
Key Uncertainties:

- Benefits: The rate at which live biomass is regenerated on restored lands versus lands that do not receive any restoration treatment.
- Costs: The representativeness of the cost/acre data in the survey by Conrad (footnoted below). The high end of the cost range was used in this analysis.

Ancillary Benefits and Costs:

Restoration of forest ecosystems; watershed protection.

[51] Fire Perimeter data from D. Ryerson USFS; http://www.fs.fed.us/r3/gis/az_data.shtml.
[52] Conrad, G. Summary Report On State Reforestation and Tree Planting Statistics, Interstate Compact Mining Commission, http://www.mcrcc.osmre.gov/PDF/Forums/Reforestation/Session%201/1-4.pdf, date unknown.



Feasibility Issues:

CCS also received data on forested acres impacted by insect damage and disease. Additional GHG benefits could potentially be achieved through restoration efforts on these lands. Insects and disease impacted over 500,000 acres by 2002.[53] The TWG did not have sufficient time to explore the potential for restoring these insect-damaged areas.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

53 http://www.fs.fed.us/projects/hfi/docs/fact-sheet-arizona.pdf.

F-3a Forest Ecosystem Management – Residential Lands

Policy Description:

Manage sustainable thinning or biomass reduction from residential forestlands (intended to address fire and forest health issues) so that harvested biomass is directed to wood products and renewable energy instead of open burning or decay. This option is directed at forestlands bordering residential areas (the wildland-urban interface or WUI). Option F-3b is directed at forests in non-WUI areas.

Policy Design:

- **Goal levels:** Wildfire and other threats to forest health and sustainability, and community safety have led to a number of initiatives within the state of Arizona to reduce biomass in residential forests and woodlands. Most of these efforts include some emphasis on utilizing the extracted woody biomass for wood products and/or energy production, rather than eliminating these materials through open burning, or storage or decay off site. Although this is an existing or potential objective for many restoration and biomass treatments on these lands, a greater emphasis and focus on wood products and/or energy production, through appropriate mechanisms, incentives, etc., is recommended. In particular, a reasonable goal of utilizing 50% or more of biomass extracted from residential lands for wood products and/or energy production is recommended to be achieved by 2010 and continuing through 2020. We also recommend that current and planned fuels treatments in Arizona be accelerated, so that all high priority areas (e.g., in wild land urban interface) are treated by 2015. We further recommend that forest management practices and policies aimed at GHG reduction and carbon sequestration be reviewed by and coordinated with the Governor's Forest Health Oversight Council and Forest Health Advisory Council. It is quite likely that some policies already recommended by these councils, or may be recommended by the councils, are complementary and supportive of GHG reduction and carbon sequestration goals, while also promoting forest and ecosystem health and public safety. One of the key initiatives of the Forest Health Councils is a plan called "Sustainable Forests, Economies and Communities: A Statewide Strategy for Arizona Forests." This plan calls for spatial database development and hazard assessment, and prioritized treatments, among other things.
- **Timing:** see text above.

- **Parties:** USFS, AZ Forestry Division, City/County Governments, Private Industry
- **Other:** For the purposes of estimating GHG benefits and costs, biomass is assumed to be utilized for the production of commercial steam/space heat or residential space heat. As stated above, other end uses (electricity generation, liquid fuels, durable wood products) should also be targeted by this policy.

Implementation Method(s):

Funding Mechanisms - Provide tax incentives to reduce the capital costs of biomass energy production, including electricity generation and heating of residences and public buildings; Establish utility "Buyback Rates" for biomass derived energy where utilities offer a standard rate for which they purchase biomass generated energy (electricity and/or heat); Expand/develop renewable energy tax credits to develop new incentives for smaller distributed biomass generation.

Codes and Standards - Increase efficiency standards for wood burning equipment and appliances (e.g. wood burning furnaces and stoves).

Develop or expand existing net-metering regulations to enable smaller projects to net-meter at retail energy rates.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

- CO_2: Carbon savings occur when live and dead carbon stocks (trees, shrubs) that otherwise would decay or burn in the forest, or be left for decay and or open burning following harvest, are harvested and converted to: 1) durable wood products that store carbon; 2) to low embedded energy wood building materials that substitute for high embedded energy conventional building materials (steel and concrete); or 3) to renewable energy that displaces fossil energy use. Sustainable management ensures that replacement biomass grows back to the maximum extent on thinned sites to offset removals of live biomass. Only the benefits associated with number 3 above have been quantified.
- CH_4: New research indicates that about four percent of the carbon storage benefits of live forests are offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.
- Black Carbon: Emissions of black carbon (soot) result from combustion of biomass from open burning of land clearing, but the heating effect may be offset by the large emissions of organic material associated with biomass combustion.

Estimated GHG Savings and Costs per $MTCO_2e$:

- GHG potential in 2010, 2020: Approximately 0.46 $MMtCO_2e$/yr in both 2010 and 2020. Assumes that all biomass from mechanical treatments is diverted to energy use (displacing natural gas) and that 50% of all biomass treated by fire is diverted to energy use.

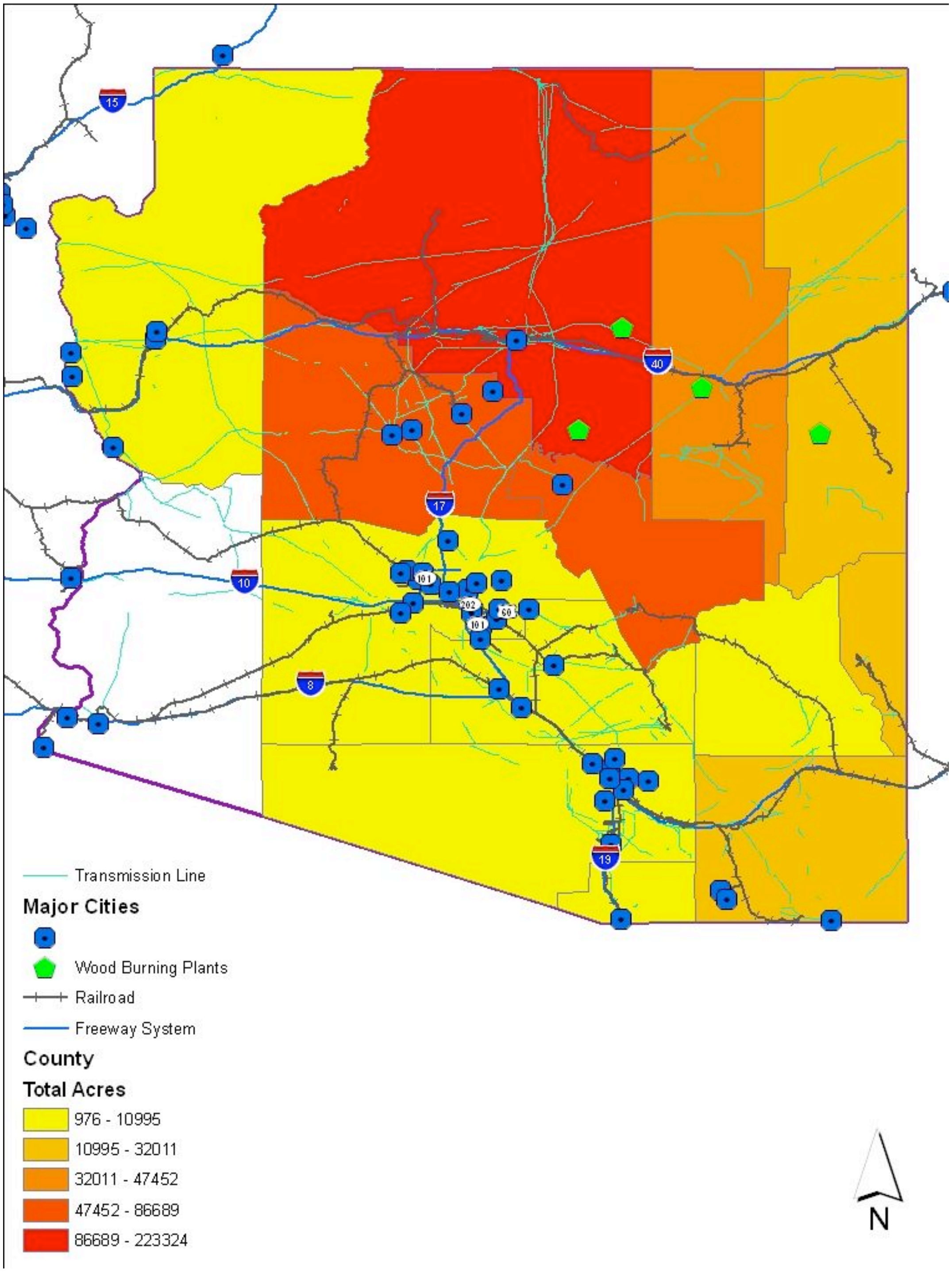
- Net Cost per tCO_2e: -$21 (based solely on displacement of natural gas; does not account for capital and annual costs associated with new biomass fired equipment.)

Data Sources, Methods and Assumptions:

- **Data Sources:** CCS obtained data on both mechanical and fire treatments conducted in AZ from 2001 – 2006.[54] These data contained information on treatments that had occurred on both wildland-urban interface (WUI) lands and non-WUI lands. The WUI lands are those considered to be residential areas applicable to this option. The average acres treated during these years was used as the starting point for analysis. A map is provided below, which has county-level information (highest level of geographic resolution that the USFS would provide) on the total number of areas treated from 2001-2006, population centers, interstates, rail, transmission lines, and the small number of biomass plants currently operating in AZ. The average carbon stocking on AZ forestlands was taken from the USFS data that underlie the AZ Inventory & Forecast (i.e. USFS FIA). Estimates of the fraction of biomass to be removed in WUI and non-WUI areas were taken from an assessment by a researcher at Colorado State University.[55] A reduction in basal area of 42% associated with an "Intermediate Restoration Level" was selected for WUI lands. The reduction in basal area was assumed to be representative of a reduction in biomass density.
- **Quantification Methods:** The amount of biomass removed was then calculated by multiplying the annual acres treated by the above ground carbon density and the treatment fraction (0.42). CCS assumed that all of the biomass from mechanically treated areas would be diverted to energy use (space heat), while biomass from 50% of the fire treated acreage would be diverted. The heat content associated with the diverted biomass was then used to estimate the equivalent amount of natural gas offset (with no adjustment for potential differences in energy efficiency). Emissions from this offset natural gas were quantified as the benefit of this option. No effort was made to quantify the embedded energy (and CO2e) associated with biomass diversion (neither were the life-cycle emissions associated with natural gas production and delivery investigated).
- **Key Assumptions:** Historical treatment areas are representative of future treatment programs. The average AZ forest carbon density is representative of areas requiring treatment (areas requiring treatment could be stocked at levels

[54] J. Roland, USFS, email communication with S. Roe, CCS, 4/26/06. Data from the National Fire Plan Operations and Reporting System (NFPORS) database.
[55] Brett Dickson, CO State Univ.; Data on forest restoration levels provided to George Koch of the AZ AF TWG on 4/05/06; "Intermediate Restoration" level of treatment selected for WUI areas; reduction in basal area assumed to be representative in reduction of above-ground biomass.

higher than the state average). Historical treatment levels selected for analysis are representative of those to be achieved in future practice.



County-level 2001-2006 AZ Fire Treatment Acreage

Key Uncertainties:

- Benefits: These initial estimates only account for utilization of the biomass as an energy source. Some fraction of this biomass could also find its way into merchantable timber. The benefits of this route of sequestration were not quantified. The market demand for new supplies of wood products and renewable energy is dynamic and not likely to fully absorb all new supply sources without offsetting decreases in other sources, unless there is support from policies that expand the market and, potentially, establish preferential treatment of these products in comparison to conventional supplies. The rate of biomass replacement growth in thinned stands could be less than full due to ecological barriers and forest health issues. Finally, the benefits associated with the lower risk of wildfire (i.e. associated carbon losses) are not quantified here, since these benefits are tied to forest treatments and this policy option is focused solely on the beneficial use of biomass energy from these treatments.
- Costs: As noted above, costs are based solely on displacement of natural gas. Capital and annual costs associated with new biomass-fired equipment (e.g. municipal boilers or residential pellet stoves) are not captured in this assessment. Future cost reductions for wood product development and biomass energy recapture technologies are likely to fall with market expansion and "learning by doing" but are difficult to estimate at this time.

Ancillary Benefits and Costs:

- Protection of residential and or municipal lands from fire risk.
- Expansion of markets for industrial producers of sustainable wood products and renewable energy use. Creation of Arizona jobs in the associated forestry management industries.
- Environmental asset protection, including watersheds, wildlife and air quality.

Feasibility Issues:

In forested areas beyond the WUI, restoring the role of fire in forest health is a major focus of the governor's forest health committees. Implementation of this policy will require coordination among state, federal, and tribal agencies to identify opportunities for beneficial use of biomass resources (e.g. cases where the risk of severe wildfire precludes the use of prescribed burns as the only management option).

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

F-3b Forest Ecosystem Management – Other Lands

Policy Description:

Increase sustainable thinning of biomass from forests and direct the harvested wood and wood waste to wood products and renewable energy. This option is directed at forests in non-WUI areas.

Policy Design:

- **Goal levels:**

  Scenario 1:

  Wildfire and other threats to forest health and sustainability have led to a number of initiatives within the state of Arizona to reduce biomass in forests and woodlands. Many of these efforts include some emphasis on utilizing the extracted woody biomass for wood products and/or energy production, rather than eliminating these materials through open burning, or storage or decay off site. Although this is an existing objective or potential objective for many restoration and biomass treatments on these lands, a greater emphasis and focus on wood products and/or energy production, through appropriate mechanisms, incentives, etc., is recommended. In particular, a reasonable goal of utilizing 50% or more of biomass extracted for wood products and/or energy production is recommended. We also recommend that current and planned fuels treatments in Arizona be accelerated, so that all high priority areas (e.g., in valuable watersheds and habitats) are treated by 2015 and continuing through 2020.

  We further recommend that forest management practices and policies aimed at GHG reduction and carbon sequestration be reviewed by and coordinated with the Governor's Forest Health Oversight Council and Forest Health Advisory Council. It is quite likely that some policies already recommended by these councils, or may be recommended by the councils, are complementary and supportive of GHG reduction and carbon sequestration goals, while also promoting forest and ecosystem health and public safety. One of the key initiatives of the Forest Health Councils is a plan called "Sustainable Forests, Economies and Communities: A Statewide Strategy for Arizona Forests". This plan calls for spatial database development and hazard assessment, and prioritized treatments, among other things. This strategic plan is still in draft form (as of 02/21/06), and it would be useful to coordinate objectives and strategies of various forest and woodland policy options from the CCAG with this plan.

Scenario 2:

Accelerated restoration levels are anticipated as economic utilization activity increases demand for small diameter timber and woody biomass and decreases amounts paid for restoration/fuel reduction treatments through "service contracts" and actually results in land managers being paid for material removed through "timber sales" - as one measure, under current conditions approximately 52,800 acres of US Forest Service land was projected to be treated by forest thinning in 2005, with 195,700 CCF of timber 5" dbh or greater removed and 229,200 tons of residue generated;

Timing of implementation: an average of 53,700 acres of US Forest Service land on 6 national forests are proposed to be treated per year by thinning from 2005 thru 2015, with an annual average of 192,500 CCF of timber over 5" dbh removed and 248,800 tons of residue generated, under current conditions. The acreage used to estimate benefits were taken from historical USFS treatment data (see data sources for F-3a above). For non-WUI areas, the acreage used was slightly lower than the initial policy design noted above. Annual acres treated from 2008 through 2020 are approximately 45,000.

Other: Current emphasis is on the wildland/urban interface zones throughout the state where communities and infrastructure are threatened by destructive wildfire, most have developed "Community Wildfire Protection Plans"; AZ Forest Health Oversight/Advisory Councils are developing a proposal – "Sustainable Forests, Economies and Communities: A Statewide Strategy for Arizona Forests" that will prioritize treatments statewide; focus mostly on ponderosa pine forests, but pinyon-juniper woodland treatments also needed.

- **Timing of implementation:** See discussion above.
- **Parties:** US Forest Service; AZ State Land Dept.; DOI; Tribal lands; fire department & fire district fuel management crews; private landowners; local community based groups – AZ Sustainable Forest Partnership, Greater Flagstaff Forests Partnership, Prescott Area Wildland/Urban Interface Commission, etc.
- **Other:** For the purposes of estimating GHG benefits and costs, biomass is assumed to be utilized for the production of commercial steam/space heat or residential space heat. As stated above, other end uses (electricity generation, liquid fuels, durable wood products) should also be targeted by this policy.

Implementation Method(s):

See Option F-3a.

Related Policies/Programs in Place:

See Option F-3a for a list.

Types(s) of GHG Benefit(s):

- CO_2: Carbon savings occur when live and dead carbon stocks (trees, shrubs) that otherwise would decay or burn in the forest are harvested and converted to: 1) durable wood products that store carbon; 2) to low embedded energy wood building materials that substitute for high embedded energy conventional building materials (steel and concrete); or 3) to renewable energy that displaces fossil energy use. Sustainable management ensures that replacement biomass grows back to the maximum extent on thinned sites to offset removals of live biomass. Only the benefits associated with number 3 above have been quantified.
- CH_4: New research indicates that about four percent of the carbon storage benefit of live forests is offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.
- Black Carbon: Emissions of black carbon (soot) result from combustion of woody biomass from open burning of land clearing, but the heating effect is likely to be offset by the cooling from the large amount of organic material emitted from biomass combustion.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 0.21 MMtCO2e/yr in both years (assumed constant treatment acreage)
- Net Cost per $MtCO_2e$ in 2010, 2020: -$21 (accounts for the costs associated with offsetting natural gas; does not include costs associated with the purchase of new biomass-fired equipment)

Data Sources, Methods and Assumptions:

- **Data Sources:** See discussion under F-3a above for a description of the data sources used. For non-WUI areas, the treatment level was assumed to be the "Fuels Reduction" level of restoration from the same source cited under F-3a. This led to a 21% reduction in biomass (and carbon) density on the treated acres.
- **Quantification Methods:** See the discussion under F-3a. The same approach was applied for non-WUI lands using a different level of treatment (21% reduction) as mentioned above.
- **Key Assumptions:** See Option F-3a above.

Key Uncertainties:

- Benefits: The market demand for new supplies of wood products and renewable energy is dynamic and not likely to fully absorb all new supply sources, unless there is support from policies that expand the market and, potentially, establish preferential treatment of these products in comparison to conventional supplies. The rate of biomass replacement growth in thinned stands could be less than full due to ecological barriers and forest health issues. The benefits associated with the lower risk of wildfire (i.e. associated carbon losses) are not quantified here, since these benefits are tied to forest treatments and this policy option is focused solely on the beneficial use of biomass energy from these treatments.

- Costs: Future production cost reductions for wood product development and biomass energy recapture technologies are likely to fall with market expansion and "learning by doing" but are difficult to estimate at this time.

Ancillary Benefits and Costs:

- Protection of working lands and associated industries for sustainable wood products use, recreation, cultural and natural heritage.
- Expansion of markets for industrial producers of sustainable wood products and renewable energy use. Creation of Arizona jobs in the associated forestry management industries.
- Environmental asset protection, including watersheds, wildlife and air quality.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

F-4 Improved Commercialization of Biomass Combustion, Gasification and Combined Cycle

Policy Description:

Accelerate the rate of technology development and market deployment of biomass combustion, gasification and combined cycle (BGCC) technologies.

Policy Design:

- **Goal levels:** 10 megawatts of biomass energy between 2006 and 2010, and an additional 25 megawatts between 2010 and 2020 (or equivalent amount of new biomass thermal energy).
- **Timing:** see above.
- **Parties:** Western Energy Resources (Eager); Renergy Systems (Snowflake); Northern Arizona University (Flagstaff); Camp Navajo/Volunteer Mountain Industrial Park (Bellemont); Forest Energy (Snowflake & Bellemont); Arizona Public Service, APS Energy Services; Salt River Project; Tucson Electric Power; Rural Electric Cooperatives
- **Other:** technology improvements required to reduce emissions & improve efficiency of direct combustion; development of full scale commercial gasification systems needed; improved efficiencies for alcohol production from cellulose needed; appropriate technologies to efficiently remove and transport biomass from forests need to be in place

Implementation Method(s):

Funding mechanisms and or incentives [USDA/DOE Biomass Initiative RFP; private investment; surcharges on Renewable Energy Standard & Tariff (RES, formerly EPS)], Voluntary and or negotiated agreements [power purchase agreement; stewardship contracts to assure supply of biomass], Codes and standards [Environmental Portfolio Standard revisions, proposed as RES], Market based mechanisms [green tags & RES credits], Pilots and demos [gasification systems; 3 MW ChipTek Unit of APS; Western Energy Resources; Renergy], Research and development [NAU systems]

Related Policies/Programs in Place:

USDA/DOE Biomass Initiative; RES proposals approved.

Types(s) of GHG Benefit(s):

- CO_2: Carbon savings occur when biomass energy combustion processes are converted from conventional technology to new technologies with greater thermal efficiency and reduced emissions with lower pollution outputs. New conversion technologies also may expand the use of available biomass supplies that substitute biomass energy for conventional fossil fuels. Increased efficiency & reduced emissions from burning/gasifying biomass in plants rather than "slash burning" in the forest as currently done. There will be significant reductions in CO_2 released from wildfire combustion of forest biomass when thinning treatments restore forest health and reduce the occurrence, area extent and intensity of wildfires; needs to be offset with contributions from increased prescribed burning necessary to maintain forest health.
- CH_4: New research (Nature 2006) indicates that about four percent of the carbon storage benefits of live forests is offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.
- Black Carbon: Emissions of black carbon (soot) result from combustion of woody biomass from open burning of land clearing, but the heating effect is likely to be offset by the cooling effects of the large amount of organic material emitted during biomass combustion (CCS, 2006).

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: Not quantified (forest biomass energy currently quantified under Options F-3a and F-3b.
- Net Cost per $MMTCO_2e$ in 2010, 2020: Not quantified.

Data Sources, Methods and Assumptions:

- Data Sources: Steve Gatewood, AF TWG, provided the following data on the estimated costs and criteria pollutant production at biomass gasification facilities planned or proposed for application in AZ.
  - The existing 3MW Eager WER/APS plant consumes 110 tons/day of 40% moisture biomass, with approx. 46 tpy PM10, 52 tpy PM, 95 tpy CO, 4 tpy SOX, 35 tpy NOX & 6 tpy VOC; cost unknown;
  - The ChipTek 3MW plant (not online yet – may go to NAU) consumes ~100 tons/day of 20% moisture chips, with approximately 45 tpy PM10, 52 tpy PM, 94 tpy CO, 4 tpy SOX & 35 tpy NOX; cost is about $7.8M;
  - The proposed/permitted 24MW Renergy Snowflake plant would consume 480 tons/day of 50% moisture biomass, with approx. 23 tpy PM10, 252 tpy CO, 156 tpy SOX, 205 tpy NOX & 22 tpy VOC; cost is unknown;
  - A 10MW plant proposed for Snowflake that might be replaced by the above 24 MW would use 295 tons/day of 38% moisture biomass, with 44 tpy PM10, 58 tpy CO, 11 tpy SOX, 57 tpy NOX & 8 tpy VOC; cost unknown;

- A 10MW gasification system proposed for NAU would use 248 tons/day of 40% moisture biomass, with unknown emissions; cost would be ~ $15M.

- Quantification Methods: The costs and benefits of this option were not quantified due to the overlap in biomass energy resource consumption with F-3a and F-3b above. The TWG feels that this option supporting advancement of biomass gasification/combined cycle technology could produce even better GHG benefits than those shown for F-3a and F-3b.
- Key Assumptions: none.

Key Uncertainties:

- Benefits: The market demand for new supplies of renewable energy is dynamic and not likely to fully absorb all new supply sources without offsetting decreases in other sources, unless there is support from policies that expand the market and, potentially, establish preferential treatment of these products in comparison to conventional supplies.
- Costs: Future production cost reductions for biomass energy recapture technologies is likely to fall with market expansion and "learning by doing" but are difficult to estimate at this time.

Ancillary Benefits and Costs:

- Criteria air pollution levels are lower with advanced technology. Gasification reduces emissions below the levels emitted via direct combustion.
- Alcohol production can reduce emissions of GHGs by offsetting gasoline use.
- Expanded biomass energy use also expands rural biomass industries.
- Eliminates open burning of slash – reduced smoke impacts and emissions and scarification of soils with resulting exotic species invasion.
- Significant reductions in emissions & pollutants through controlled combustion or gasification compared to open burning of slash or large wildfire releases.
- Criteria air pollution levels are lower with advanced technology than conventional biomass technology. Emission levels might not be as low as some conventional fossil fuel technologies (e.g., natural gas combustion technologies)
- Expanded biomass energy use also expands rural biomass industries.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

A-1a Manure Management - Manure Digesters

Policy Description:

Reduce CH4 emissions from livestock manure through the use of manure digesters installed at dairies. Energy from the manure digesters is used to create heat or power, which offsets fossil fuel-based energy production and associated CO2 and black carbon emissions.

Policy Design:

- **Goal levels:** Manage dairy manure using anaerobic digesters and energy capture technology (e.g. electricity generators) covering 25% of the statewide dairy population by 2010. Increase this level to 75% of the dairy population by 2020. Because use of manure digesters at beef feedlots are not as far along in development as dairy applications, implement at least three demonstration projects at large beef feedlots (>5,000 head) by 2010. This represents about 5% of the current feedlot population. Expand the use of digesters or other energy production technology at beef feedlots to 50% of the feedlot population by 2020.
- **Timing:** See discussion under goal levels above.
- **Parties:** Arizona Department of Agriculture, Universities, Arizona Department of Environmental Quality, Industry Associations, Dairies

Implementation Method(s):

Funding Mechanisms – funding mechanisms (grant programs, low interest loans) might be needed to reduce the capital costs and provide net savings to livestock producers. *Research and Development* – additional research should be performed to identify the best technologies suited for energy development at AZ dairies/feedlots. For at least one of the feedlot demonstration projects, investigate the potential of a combined manure digester and ethanol production plant. In these projects, the spent grain from the ethanol process is used as feed for the cattle. Heat and electricity produced from the manure digester is used in the ethanol plant to reduce fossil-based energy use.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

- CO_2: Use of methane captured in manure digesters to generate electricity displaces fossil fuel use and associated CO_2.
- CH_4: Manure digesters collect and combust the CH_4 produced from anaerobic decomposition during manure storage.
- N_2O emissions from manure management are not likely to be affected by this policy option. N_2O emissions from fossil fuel-based electricity will be offset.
- Black Carbon: Use of methane captured in manure digesters to generate electricity displaces fossil fuel use and associated BC emissions.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 2010 Dairies = 0.14 MMtCO2e; 2020 Dairies = 0.43 MMtCO2e; Feedlots 2010 = 0.0004 MMtCO2e; 2020 Feedlots = 0.007 MMtCO2e.

Net Cost per $MtCO_2e$: Dairies = $7/MtCO2e; Feedlots = $390/MtCO2e

Based on the high costs and moderate GHG reductions for feedlots, only the benefits and costs for dairies are included in the policy summary at the beginning of this document.

Data Sources, Methods and Assumptions:

- **Data Sources: Data** from the GHG inventory & forecast report on methane emissions and dairy/feedlot populations were used as the starting point. It is important to note that the TWG did not want to assume any growth in either the dairy or feedlot cattle populations in future years. Hence, they were kept at 2004 levels. Methane emissions at feedlots are much lower than those at dairies due to the differences in manure management and storage at these different operations. Consistent with the policy design, manure digesters are assumed to be implemented at dairies covering 25% of the state population by 2010. By 2020, 75% of the dairy cattle population is assumed to be covered. For feedlots, 5% of the feedlot cattle are covered in 2010 and 50% are covered by 2020.

  For each facility that installs manure digester or other energy capture/utilization technology, it is assumed that 75% of the methane emissions are collected (due to inefficiencies in the manure collection process). This methane is converted to electricity using a heat rate of 17,100 Btu/kW-hr. The annual kW-hrs produced was used to estimate both the costs offset (through avoided electricity consumption), as well as GHGs offset (from grid power). The 2010 grid power emission factor used was 1.607 lb CO2e/kW-hr. For 2020, this value was 2.223 lb CO2e/kW-hr (which factors in a higher level of coal-based power production in 2020). These values were taken from the AZ GHG Inventory & Forecast Report.

  The CO2e reduction benefits were calculated as the sum of the methane emissions reduced, plus the GHG offset from grid-based power. Costs were estimated using data on capital costs from EPA's Methane to Markets report[56] and a recent dairy manure digester application in central California. These data indicate a range of capital costs from about $190 to $450 per head. An annual operating cost of $38/head was also estimated from the central California project.[57] Electricity offset cost of $0.04/kW-hr was also used. High and low annualized costs were estimated using the high and low estimates of capital costs. The reported costs for the policy are the mid-range of these estimates. A 15-year project life was assumed along with a 5% interest rate to determine the capital recovery factor.

- **Quantification Methods:** See discussion above**.**
- **Key Assumptions:** No further growth in dairy and feedlot operations in AZ (data indicate nearly 5% annual growth in the dairy herd since 1990).

  Most applications of manure digesters in the U.S. have been done at dairies with liquid (slurry) manure management systems. For livestock operations that manage manure primarily in solid form, there could be major differences in energy technology selected (e.g. for solid manure, biomass gasification might be a better alternative). These different technology choices could carry higher or lower costs than those used here for anaerobic lagoon digesters combined with an engine and electricity generator. CCS believes that the range of costs considered in this analysis represents, on the low end, manure energy projects implemented for a group of farms (e.g. regional digesters/energy plants) to high-end costs, where the digester/energy plant is implemented at a single facility.

Key Uncertainties:

The effects of the no growth assumption above. This could lead to a significant underestimate of future benefits. The costs associated with anaerobic digester/energy plant application at AZ dairies and their representativeness to the energy technology actually selected.

Ancillary Benefits and Costs:

- Reduction of ammonia, VOC emissions, and odor.
- Reduction of fossil fuel-based energy consumption.
- Could enhance the value of manure through higher demand for manure overall and potentially higher quality of digested manure.

Feasibility Issues:

- In the U.S. about 7% of greenhouse gas emissions are from agriculture, with the major source of agricultural emissions being nitrous oxide from agricultural soils. About 25% of agricultural emissions come from waste management activities and

[56] http://www.methanetomarkets.org/resources/ag/docs/animalwaste_prof_final.pdf accessed March 2006.
[57] Williams, Douglas, Valley Air Solutions, presentation "Joseph Gallo Farms Dairy Manure Digester", January 18, 2006.

about 25% from enteric fermentation. We have a lot of interest in developing domestic energy sources, especially in rural areas where electricity is more difficult and expensive to obtain. We would like to focus on making some of these technologies more affordable (e.g., high initial cost of anaerobic digesters compared to other management methods).

- Need to identify methods for integrating this form of distributed power into the power grid in AZ.
- Due to the current high costs and relatively low benefit associated with energy utilization at feedlots, the TWG recommends limiting this option to dairies only. For feedlots, the TWG recommends additional research and pilot projects to assess the viability of energy recovery projects.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

Due to high costs, the CCAG recommends additional research and development to identify cost effective energy utilization methods for feedlot manure.

A-1b Manure Management – Land Application

Policy Description:

Reduce N2O emissions from daily spread and other land application of dairy and feedlot cattle manure through the use of better application methods, such as direct injection of liquid waste. These application methods are designed to reduce contact of manure nitrogen with air (lowering the rate of denitrification) and the amount of manure nitrogen loss via leaching and runoff.

Policy Design:

- **Goal levels:** Program goal of changing manure land application methods for 20% of beef and dairy cattle by 2010 and 50% of beef and dairy cattle by 2020.
- **Timing:** See goal above.
- **Parties:** AZ Department of Agriculture, Arizona Department of Environmental Quality, Agricultural Extension Offices, dairy and feedlot operators.

Implementation Method(s):

Not considered.

Related Policies/Programs in Place:

Not considered.

Types(s) of GHG Benefit(s):

- N2O: Reduces N20 emissions by minimizing manure nitrogen contact with air; or nitrogen losses via leaching or runoff which result in subsequent N20 emissions.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: Not Quantified (see discussion under Data Sources below).
- Net Cost per MMTCO$_2$e in 2010, 2020: Not Quantified.

Data Sources, Methods and Assumptions:

- **Data Sources:** There are little data available on the reductions of N2O associated with different manure application methods. Most previous studies have focused on reductions in NH3 (ammonia) emissions, increased nitrogen uptake by crops, or lower nitrogen runoff. CCS identified one source of information that suggested that subsurface application of manure could lower nitrogen oxide (NO) emissions, but actually raises N2O emissions.[58]

- **Quantification Methods:** Due to the lack of available data on GHG reduction potential, benefits and costs for this option were not quantified.
- **Key Assumptions:** Not applicable.

Key Uncertainties:

See data sources above.

Ancillary Benefits and Costs:

- Reduction of ammonia, VOC emissions, and odor.
- Increased in nitrogen utilization by crops and pastures.
- Decreased leaching and runoff of nitrogen to ground and surface water.

Feasibility Issues:

Data were not identified to assess the technical feasibility of this option (i.e., N2O emission reductions due to better application methods).

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

[58] http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/004/Y2780E/y2780e02.htm.

A-2 Biomass Feedstocks for Electricity or Steam Production

Policy Description:

Displace fossil fuel usage through the use of agricultural waste (e.g., orchard trimmings, other crop residue) as a feedstock for electricity, steam, or space heat production.

Policy Design:

- **Goal levels:** Program goal of using 50% of available agricultural biomass residue for energy use by 2020.
- **Timing:** 20% of available biomass used by 2010, 50% by 2020.
- **Parties:** Arizona Department of Agriculture, Agricultural Cooperative Extension Offices, Arizona Department of Environmental Quality, Arizona Growers Association, Crop Producers.
- **Other:** For the purposes of quantifying the costs and benefits of this option, biomass energy was assumed to be pelletized and used for commercial or residential space heating or steam production. The benefits were estimated by quantifying the amount of fossil fuel displaced (assumed to be natural gas).

Implementation Method(s):

Pilots and Demonstrations – Pilot projects on the use of different residues for energy production are needed; *Research and Development* – Research is needed on techniques for collecting and processing crop residues, as well as markets for these materials; *Market-Based Mechanisms* – Incentives (e.g. preferential tax rates) may be needed to spur the use of biomass energy.

Related Policies/Programs in Place:

None identified.

Types(s) of GHG Benefit(s):

- CO2: Savings occur as a result of displacing fossil fuel use in the production of electricity or steam.
- CH4: Not applicable (savings only occur if it can be demonstrated that biomass combustion produces less methane than fossil-based combustion)
- N2O: Not applicable (savings only occur if it can be demonstrated that biomass combustion produces less methane than fossil-based combustion)

- HFC's, SFC's: Not applicable
- Black Carbon: Likely to be a reduction in BC emissions to the extent that coal-based combustion is offset (if electricity is generated from any of the biomass utilized).

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 0.05 MMtCO2e in 2010, 0.13 MMtCO2e in 2020
- Net Cost per $MtCO_2e$ in 2010, 2020: -$8/MtCO2e

Data Sources, Methods and Assumptions:

- **Data Sources:** Harvested acres for corn grain, sorghum, barley, oats, winter wheat, and durum wheat, and orchards were obtained from USDA NASS[59]. Per acre crop residue the USDA and US DOE took yields for grain crops from a joint study[60]. An estimate of biomass yields from orchard trimmings was taken from a report from the National Renewable Energy Laboratory[61]. Estimates of the energy content in kWh/ton for switchgrass pellets (used to estimate crop residue) were obtained from Resource Efficient Agricultural Production Canada[62]. The energy content for wood pellets was taken from a wood pellet brochure[63]. The delivered costs for biomass pellets were obtained from Resource Efficient Agricultural Production Canada[64]. A comparison of the biomass resources available using the above data to the Western Governors' Association's Clean and Diversified Energy Advisory Committee's (CDEAC) report on regional biomass resources[65] yielded very similar results (301,000 dry tons of residue compared to the CDEAC estimate of 317,000).
- **Quantification Methods:** Acreage data and the tons of crop residue (or orchard trimmings) per acre were used to estimate the total amount of available biomass from existing crops. Estimates of the energy content for switchgrass pellets (19.3 MMBtu/ton for crop residues) and wood pellets (16.4 MMBtu/ton for orchard trimmings) were used to estimate the total energy that could be generated using biomass pellets. The amount of CO2e avoided by burning biomass instead of natural gas was estimated by subtracting the biomass emission factor (14.96 lbs CO2e/MMBtu) from the residential natural gas emission factor (116.7 lbs CO2e/MMBtu). No adjustments were made for the potential differences in efficiencies between the natural gas fired and biomass fired equipment.

[59] AZ State Agriculture Overview – 2005, http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_AZ.pdf
[60] Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply, 2004, http://www.ethanolrfa.org/objects/documents/92/billion_ton_vision.pdf
[61] Lessons Learned from Existing Biomass Plants, NREL, 2000, http://www.nrel.gov/docs/fy00osti/26946.pdf
[62] Grass Biofuel Pellets, http://www.reap-canada.com/bio_and_climate_3_2.htm
[63] http://www.energycentre.info/pdf/dokumentarkiv/brochure_about_wood_pellets.pdf
[64] Grass Biofuel Pellets, http://www.reap-canada.com/bio_and_climate_3_2.htm
[65] 2005. WGA Clean and Diversified Energy Advisory Committee (CDEAC) Biomass Supply Report - http://www.westgov.org/wga/initiatives/cdeac/Biomass-supply.pdf.

- **Key Assumptions:** Crop acreage for grains was assumed to remain constant for 2005-2020 and orchard acreage was assumed to remain constant for 2002-2020. The energy content and pelletizing costs for AZ crop residue were assumed to be the same as for an analysis of pelletized switchgrass conducted in Canada.

Key Uncertainties:

- **Benefits:** The values for crop residue yields are based on National values, and may differ for crops in Arizona. The energy content of Arizona crop residue may differ from that of switchgrass. Another uncertainty is the acreage of potential biomass crops in 2010 and 2020. The benefits are quantified as the amount of fossil fuel (natural gas) offset with biomass energy for space heating. Full life-cycle GHG benefits (i.e. embedded energy) for the production of pelletized biomass and natural gas were not incorporated into this analysis.
- **Costs:** The costs of production and transport of pellets made from crop residue and orchard trimmings may differ from that of switchgrass.

Ancillary Benefits and Costs:

- Increased costs associated with collecting and transporting biomass.
- Increased emissions associated with collection and transport
- Decrease in emissions in some cases – e.g. situations where open burning of residue is replaced by controlled combustion.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

A-3 Ethanol Production

Policy Description:

Provide incentives for the production of ethanol from crops, agricultural waste, or other materials. Use of the ethanol will offset fossil fuel use (gasoline). Different incentive programs will be needed for crop (starch-based) ethanol production versus agricultural waste (cellulosic) ethanol production processes.

Policy Design:

- **Goal levels:** Three production goal options were assessed. The first involved production of enough ethanol to support the use of E10 (10% ethanol by volume in gasoline) year round in areas that currently uses it during the winter season (Maricopa, northern Pinal, and Pima Counties). Year round use would more than double the current usage levels of ethanol in AZ. The second option involved producing enough ethanol to support alignment with the New Mexico CCAG goal of 20% ethanol usage by volume in gasoline by 2012. The third option was alignment with the NM CCAG goal of 40% ethanol by 2030.
- **Timing:** The timing for the first option is by 2010. This would require the production of 207 MMgal/yr. The second option is to be achieved by 2020, and it would require the production of 858 MMgal/yr at that time. The third option would require production of 3,450 MMgal/yr by 2050. Note: production from the new Pinal county facility (55 MMgal/yr capacity) is included in the forecasted goals.
- **Parties:** Arizona Department of Environmental Quality, Arizona Department of Agriculture, various industries and industry associations which produce feedstock for ethanol production (growers, solid waste, forest products, etc.).

Implementation Method(s):

Pilots and Demonstrations – Incentives are needed to attract investment in commercial cellulosic ethanol production plants; *Research and Development* – Additional research is needed to identify the availability of appropriate feedstocks for ethanol production. The new Pinal Energy Plant is expected to take up a significant fraction of the potential corn production in the state. Additional feedstocks for starch-based production are probably limited in AZ. Cellulosic feedstocks should be identified for commercial application; *Market-Based Mechanisms* – This policy option focuses strictly on the production of ethanol for use in transportation. Programs are needed to assure sufficient in-state demand for ethanol (e.g. a renewable fuels standard). The Transportation and Land Use TWG handle the demand-side issues.

Related Policies/Programs in Place:

None identified.

Types(s) of GHG Benefit(s):

- CO2: offsetting the use of petroleum-derived gasoline and diesel reduces CO2 emissions. Energy requirements of producing ethanol need to be compared to the energy requirements of producing gasoline to completely assess the CO2 benefit. While both starch-based and cellulosic ethanol production processes produce GHG benefits, the benefits from cellulosic ethanol are much higher and were used to estimate the benefits for this option. See the discussion below.
- Black Carbon: Differences in BC emissions between gasoline and ethanol-blended gasoline are probably negligible.

Estimated GHG Savings and Costs per MTCO2e:

Option 1:

- GHG reduction potential in 2010, 2020: 0.49 MMtCO2e; 0.64 MMtCO2e.
- Net Discounted Cost per $MtCO_2e$ through 2020: $151

Option 2:

- GHG reduction potential in 2020, 2050: 4.03 MMtCO2e; 8.46 MMtCO2e
- Net Discounted Cost per MtCO2e through 2020: $149

Option 3:

- GHG reduction potential in 2050: 18.4 MMtCO2e

Data Sources, Methods and Assumptions:

- **Data Sources:** Production volumes for each scenario in each year are based on forecasted gasoline consumption (from the AZ Inventory & Forecast), current and planned ethanol production in the state, and the volume of gasoline to be offset in each year. Costs for all ethanol production are based on estimates for cellulosic technology[66] and do not include the costs for the new Pinal Energy Plant.
- **Quantification Methods:** Well-to-wheels CO2e emission factors from a recent Argonne National Laboratory Study were used to estimate the benefits of offsetting conventional gasoline with starch-based ethanol (from the Pinal Energy Plant) and cellulosic ethanol for all incremental production needed to fulfill the

[66] Charles Bensinger, Sunbelt Biofuels, personal communication with S. Roe, CCS. Costs based on cellulosic plants in the 7 to 11 MMgal/yr production range. Plants use either manure or municipal solid waste as feedstock. Plants are profitable at ethanol prices of $1.90/gal (current price is $2.70/gal). Costs to produce cellulosic ethanol range from $1.28 - $1.40/gal.

policy goals. Well-to-wheels emission factors take into account the energy required to produce, process, and transport each fuel type (i.e., starting with the oil well for gasoline and the crop for starch-based ethanol). These emission factors are output from Argonne National Lab's GREET Model (all based on an average fuel economy of 21 mi/gal:

Reformulated gasoline = 552 g CO2e/mi;

Corn (starch) ETOH = 451 g CO2e/mi;

Cellulose ETOH = 154 g CO2e/mi.

As shown in these emission factors, use of corn (starch-based) ethanol results in a CO2e reduction of about 18% relative to the use of reformulated gasoline. Cellulosic ethanol consumption results in a CO2e reduction of about 72%. Although the TWG did not recommend that this policy should target only incentives to cellulosic ethanol production, benefits of this option were estimated assuming that additional ethanol production capacity in AZ (beyond the Pinal Energy Plant) would come from cellulosic ethanol.

The costs to produce cellulosic ethanol were taken from recent analyses of a member of the New Mexico Climate Change Advisory Group.[21] Costs for the Pinal Energy Plant were not included in the assessment.

- **Key Assumptions:** These include – future ethanol production in AZ will come from cellulosic ethanol plants; production volumes are set at one of the selected scenarios; current costs for cellulosic ethanol production are accurate and not expected to change considerably over the policy period (thru 2020); current ethanol prices will not fall substantially to the point of making near term cellulosic plants economically infeasible.

Key Uncertainties:

Representatives of ANL's GREET model emission factors to starch-based and cellulosic ethanol production associated with AZ-specific feedstocks and production facilities; future costs of cellulosic ethanol production (plants in the near future are likely to use enzymatic processes that have lower costs than today's acid hydrolysis technology).

Ancillary Benefits and Costs:

- Gasoline-ethanol blends may increase or decrease emissions of some criteria and toxic air pollutants (decrease in aromatic hydrocarbons, such as benzene, toluene, and xylenes; increases in aldehydes, like formaldehyde and acetaldehyde)
- In-state job growth;
- Creates markets for current waste products (e.g., municipal solid waste, forestry and crop residues, manure).

Feasibility Issues:

The current wholesale ethanol pricing makes cellulosic ethanol plants very attractive. A sharp drop (e.g. below $1.90/gallon) will have a strong negative effect on private investment. Enzymatic processes for cellulosic ethanol production are expected to be commercially available within the next 5 to 10 years.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

Members of the group expressed the need to reiterate that this option was not meant to favor cellulosic ethanol production exclusively, and that AZ should further investigate additional production potential for starch-based ethanol.

A-4 Change Livestock Feedstocks

Policy Description:

Reduce methane emissions from beef and dairy cattle by changing (optimizing) livestock feedstocks.

Policy Design:

- **Goal levels:** Change feedstock for 50**%** of dairy and feedlot cattle to a feed regimen that lowers methane emissions.
- **Timing:** 20% of dairy and feedlot cattle on methane lowering diet by 2010, 50% by 2020.
- **Parties:** Beef and dairy producers, industry associations, agricultural extension offices, Arizona Department of Agriculture.
- **Other:**

Implementation Method(s):

Not determined.

Related Policies/Programs in Place:

TWG members indicated that a significant portion of Arizona cattle is fed cottonseed as part of their regimen. The incremental benefit of additional edible oil supplementation to lower methane emissions is unknown.

Types(s) of GHG Benefit(s):

- CH4: Addition of edible oils to feedstocks can reduce CH4 emissions from enteric fermentation in cattle. Vegetable oils are more dense digestible energy sources that require less fermentation in the rumen for energy to be released.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 0.03 MMtCO2e in 2010, 0.07 MMtCO2e in 2020
- Net Cost per $MtCO_2e$ in 2010, 2020: $165/MtCO2e

Data Sources, Methods and Assumptions:

- **Data Sources:** The populations of dairy and feedlot cattle in Arizona in 2004 were obtained from the USDA[67]. Emission reductions from the addition of edible

[67] Arizona Annual Livestock, May, 2004, USDA NASS, http://www.nass.usda.gov/az/lvstk/2004/040525al.pdf

oil to cattle feedstocks and the amount of oil consumed per head was taken from a study on the effects of various feed additives on enteric fermentation methane emissions[68]. Costs for edible oils were obtained from the USDA[69].

- **Quantification Methods:** Cattle populations were assumed to remain constant from 2004 levels to 2020. Emission savings were estimated by applying the 21% emission reduction to the estimated methane emissions for 20% of the population in 2010 and 50% of the population in 2020. Costs were estimated by multiplying the cost of soybean oil ($0.23 per lb) by the amount consumed by each head of cattle (400 g/head/day or 0.88 lb/head/day).
- **Key Assumptions:** Cattle populations were assumed to remain constant from 2004 levels to 2020. Soybean oil was chosen to estimate costs, because it is less expensive than sunflower oil (the oil used in the emissions study). It was assumed that any edible oil would produce a similar reduction of methane emissions.

Key Uncertainties:

As noted above, currently many AZ cattle have cottonseed included as part of their feed. Therefore, it is unclear whether there is a significant incremental benefit achieved by the inclusion of edible oils into the feeding regimen.

Ancillary Benefits and Costs:

Potential higher value of meat products from cattle fed edible oils.

Feasibility Issues:

See uncertainties above.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

[68] McGinn et al., 2004, "Methane emissions from beef cattle: Effects of monenesin, sunflower oil, enzymes, yeast, and fumaric acid." http://jas.fass.org/cgi/content/full/82/11/3346
[69] Oil Crops Outlook, Feb, 2006, USDA ERS, http://usda.mannlib.cornell.edu/reports/erssor/field/ocs-bb/2006/ocs06bf.pdf

A-6 Rotational Grazing/Improve Grazing Crops and/or Management

Policy Description:

Increase carbon sequestration in grazing lands through rotational grazing, improvement of grazing crops, and/or grazing management.

Policy Design:

- **Goal levels:** Program goal of bringing **X** acres of poorly managed grazing land under new management practices.
- **Timing:** Acres of grazing land brought under new management practices by 2010, 2020 and 2050.
- **Parties:** Not considered.

Implementation Method(s):

Not considered.

Related Policies/Programs in Place:

None identified.

Types(s) of GHG Benefit(s):

- CO2: Carbon savings (sinks) are a result of enhanced sequestration on grazing lands. Using grazing management techniques that elevate the health status of plants on grassland ecosystems enhances sequestration.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: Not determined due to lack of data.
- Net Cost per $MMtCO_2e$ in 2010, 2020: Not determined due to lack of data.

Data Sources, Methods and Assumptions:

- **Data Sources:** The TWG was unable to find sufficient information to assess the benefits and costs of this option. No data were found to identify the grazing lands in AZ, where different management practices could be implemented to increase carbon sequestration. Further, discussions with TWG members and an outside expert did not reveal a significant potential for enhancing soil or aboveground carbon in AZ grazing lands.

Managing native vegetation on rangelands in Arizona does not represent a reliable sink for sequestering carbon in soils in the near term (10 year period). Low (<10"' average precipitation) and erratic rainfall precludes a consistent sequestration response of sufficient amounts to warrant making this option a high priority compared to other emission reduction and sequestration options. However, the management of rangelands with existing technologies to improve soil and vegetation conditions over longer periods does represent an important strategy for reducing losses of carbon and increasing soil carbon.

- **Quantification Methods:** Not quantified (see data sources above).
- **Key Assumptions:** not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

Higher quality grassland habitat for wildlife.

Feasibility Issues:

Additional research is needed to assess the feasibility of this option in AZ (see Data Sources above).

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

Members of the TWG were not comfortable in moving forward with this option due to the need for additional information to assess its technical feasibility in AZ (i.e., identification of rangelands where changes in management practices could achieve positive carbon sequestration returns). Rangelands where significant above and belowground carbon could be sequestered occur in areas of the state that receive adequate precipitation (generally above 5,000 feet). These areas are generally not the grazing lands that were historically damaged by overgrazing (desert scrub areas).

A-7 Convert Agricultural Lands to Grassland or Forests

Policy Description:

Increase carbon sequestration in agricultural land by converting marginal land used for annual crops to permanent cover (grassland or forests).

Policy Design:

- **Goal levels:** Program goal of converting **X** acres of marginal agricultural land to grassland or forest. Information on the native land cover associated with these marginal lands (forest, grassland) or their location can also be factored in to the assessment of above and below ground carbon change.
- **Timing:** Acres of land converted to grassland or forest by 2010, 2020 and 2050.
- **Parties:** Not determined.

Implementation Method(s):

Not determined.

Related Policies/Programs in Place:

Federal Conservation Reserve Program.

Types(s) of GHG Benefit(s):

- CO2: Loss of carbon to the atmosphere from tillage and fallow land is reduced by converting land to permanent cover. This increases soil carbon content. Above ground carbon stocks are increased by converting to cover with a greater ability to sequester carbon (i.e. higher biomass).

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: Not quantified.
- Net Cost per $MMtCO_2e$ in 2010, 2020: Not quantified

Data Sources, Methods and Assumptions:

- **Data Sources:** No data were identified to assess the location and acreages of marginal agricultural land in AZ. Further, it is not clear whether significant marginal agricultural lands exist beyond those that are already included in the Federal Conservation Reserve Program (CRP). Finally, unless the marginal agricultural lands are located in higher elevation areas of the state that receive adequate precipitation, the incremental carbon benefits are likely to be negligible.

- **Quantification Methods:** not applicable**.**
- **Key Assumptions:** not applicable.

Key Uncertainties:

Not applicable.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues, if applicable:

See discussion under Policy Description above.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

A-8 Reduce Permanent Conversion of Farm and Rangelands to Developed Uses

Policy Description:

Reduce the rate at which existing crop and rangelands are converted to developed uses. The carbon sequestered in soils and aboveground biomass is higher in crop and rangelands than in developed land uses.

Policy Design:

- **Goal levels:** Program goal of reducing the rate of crop and rangeland loss to 50% of the loss rate from 1982-1997 by 2020.
- **Timing:** 20% reduction in loss rate by 2010, 50% by 2020.
- **Parties:** County Governments, non-government organizations (land trusts), AZ State Land Department.

Implementation Method(s):

Information and Education; Technical Assistance; Voluntary or Negotiated Agreements; Funding Mechanisms or Incentives.

Related Policies/Programs in Place:

None identified.

Types(s) of GHG Benefit(s):

CO2: Conservation of agricultural lands retains the ability of the land to sequester carbon in soil and biomass. Agricultural lands tend to hold more carbon than developed uses. These direct benefits were quantified below. Retention of agricultural lands also indirectly reduces CO2 emissions by encouraging less suburban sprawl and the associated transportation-related emissions.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 0.08 MMtCO2e; 0.20 MMtCO2e.
- Net Cost per MtCO_2e: $65/MtCO2e.

Data Sources, Methods and Assumptions:

- **Data Sources:** The number of acres that moved from cropland, pasture, and rangeland categories to developed uses between 1982 and 1997 was obtained from the USDA Natural Resource Inventory (NRI). Agricultural land soil carbon data was taken from a study in *Soil Science* that compiled data for cultivated and uncultivated land with various soil types[70]. Estimates of soil carbon on Arizona rangeland was obtained from the STATSGO/SSURGO SOC database.

Costs for agricultural land can vary widely from as low as $200/acre in rural areas without significant water supply to as much as $100,000/acre in prime locations with high development potential.[71] Costs were estimated for this option using a cost of $2,000/acre for conservation easement. This cost represents the nationwide average determined by the American Farmland Trust.[72]

- **Quantification Methods:** The number of acres of cropland, pasture, and rangeland converted to developed uses between 1982 and 1997 was divided by 15 years to give the average number of acres lost each year. The number of acres to be saved in 2010 and 2020 were estimated by multiplying the average rate for 1982-1997 by 20% and 50%, respectively. The amount of CO2 emissions savings were estimated by assuming that for each acre lost to development, 10,000 sq ft (0.23 acre) losses 100% of the soil carbon. The remainder of the acre losses 25% of soil carbon.
- **Key Assumptions:** Aboveground carbon stocks for agricultural lands and rangeland was assumed to be small compared to soil carbon. For each acre of land lost to development, 10,000 sq ft is assumed to loss 100% of the soil carbon. This area represents the area in buildings, streets, and other structures that cover the soil. A loss of 25% of the soil carbon is assumed for the remainder of the acre.

Key Uncertainties:

The main areas of uncertainty are the existing soil carbon stocks and the change in soil carbon when land is developed.

Ancillary Benefits and Costs:

Directing growth to more efficient locations may also reduce transportation emissions.

Feasibility Issues:

None identified.

Status of Group Approval:

Completed

[70] Mann, L.K. 1986. Changes in soil carbon storage after cultivation. Soil Science 142(5):279-288.
[71] Bob Findling, The Nature Conservancy, and personal communication with H. Lindquist, CCS, June 2006.
[72] American Farmland Trust, A National View of Agricultural Easement Programs, http://www.aftresearch.org/PDRdatabase/NAPidx.htm.

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

A-9 Programs to Support Local Farming/Buy Local

Policy Description:

This option seeks to promote consumption of locally produced agricultural commodities, which would offset consumption of commodities transported from other states or countries. It includes the modification, enhancement and further development of local farm programs employed in Arizona to reduce transport-related GHG emissions.

Policy Design:

- **Goal levels:** The object of expanding local farm programs and coordinating existing community programs is to increase consumption of agricultural products from sources within Arizona. In addition to the benefits of reducing fuel usage, transportation costs and air pollutant emissions, consuming locally grown foods will directly support Arizona producers, consumers and retailers. This policy looks to increase consumption of Arizona grown commodities by 10%, thereby offsetting commodities transported from other states/countries by the same amount.
- **Timing:** While reducing greenhouse gases in Arizona and achieving a 10% increase in the consumption of local farm commodities, the expansion, coordination, development and implementation of local farm programs requires financial support and "cause marketing" that will connect consumers to the value of sustaining Arizona's agricultural industry. To achieve the goal of this policy, implementation milestones are estimated at 5% by 2010 and another 5% by 2020 (total of 10% offset in 2020).
- **Parties:** Agricultural producers, industry, communities, government and others in Arizona**.**

Implementation Method(s):

Information and Education; Technical Assistance; Codes and Standards – including State government preferred purchases for local agricultural commodities; *Market-Based Mechanisms*; *Research and Development* – including research into methods to measure and monitor in-state and local agricultural commodity purchases and imported commodities.

Related Policies/Programs in Place:

Community Supported Agriculture Farmers Markets, North American Farmer's Direct Marketing Association (NAFDMA), Farmers' Market Nutrition Program (FMNP), Arizona Grown Program, The 5-A-Day for Better Health Program, U-Pick Programs Greenhouse Production, Agritainment Business.

Estimated GHG Savings and Costs per MTCO2e:

- GHG potential in 2010, 2020: 0.01 MMtCO2e, 0.02 MMtCO2e
- Net Cost per MMTCO$_2$e in 2010, 2020: Not quantified.

Data Sources, Methods and Assumptions:

- **Data Sources:** Estimates of harvested acres, crop yields, and crop value and production estimates for beef and dairy products were taken from AZ Agricultural Statistics 2004. Estimates of state exports were obtained from the USDA Economic Research Service (ERS).[73] U.S. per capita consumption rates was obtained from the ERS Food Consumption (Per Capita) Data System.[74] Arizona population data were obtained from the Arizona Department of Economic Security.
- **Quantification Methods:** The amount of each crop produced in Arizona was estimated using harvested acres and estimates of crop yields per acre. The amount of each crop consumed in Arizona was estimated using U.S. per capita consumption rates and the Arizona population. State export values were reported for commodity class. These values were allocated to each crop based on the crop value for each individual crop compared to the total value for all crops in the commodity class. Export values were then converted from dollars to weight using an estimated price calculated from the crop production value and amount produced for each crop. The amount consumed and exported for each crop was then subtracted from the amount produced to determine how much of the crop was imported. For each imported crop, a likely state of origin was chosen (CA for carrots, tomatoes, onions, grapes, eggs, and milk; OK for beef; Idaho for potatoes). The estimated amount of imports for each crop and the estimated round-trip mileage were then used to estimate ton-miles transported and CO2 emissions. These calculations were repeated for 2010 and 2020 using population projections to estimate future consumption. Reductions were estimated by multiplying the 2010 emissions by 0.05 (representing 5% offset of imported food) and the 2020 emissions by 0.10 (10% offset).
- **No data were identified to estimate the costs of this option.** It is possible that the elements of this policy could be incorporated into existing programs (see above), resulting in little or no cost.
- **Key Assumptions:** Transportation emissions were estimated by assuming 23 tons of payload per truck, 6 truck miles per gallon of diesel fuel and 22.4 lb CO2

[73] State Export Data, http://www.ers.usda.gov/Data/StateExports/.
[74] Food Availability: Spreadsheets, http://www.ers.usda.gov/Data/FoodConsumption/FoodAvailSpreadsheets.htm.

per gallon of diesel fuel. To estimate miles traveled, food from CA was assumed to travel from Fresno to Phoenix (600 miles), food from OK was assumed to travel from Oklahoma City to Phoenix (1,000 miles), food from ID was assumed to travel from Boise to Phoenix (1,150 miles). These mileage estimates were then doubled, since it was assumed that each truck would return to its point of origin empty. The amount of food produced and exported is assumed to remain constant, while consumption is assumed to grow with population.

Key Uncertainties:

One uncertainty is the amount of food products leaving the state. State export data from ERS includes only foreign exports. These estimates do not include state-to-state exports. Also, these estimates do not take into account that a large portion of some crops may be shipped out of state when they are in season, and imported into the state when they are not in season. The benefits were quantified at the state level. As such, they do not capture additional GHG benefits where local (e.g. community-level) production and consumption takes place (resulting in addition ton-mile reductions). The quantified benefits could also be conservatively low since the assumptions for out of state produce were based on the nearest likely producer state. Many commodities come from much further away (including foreign countries) and can travel by more energy intensive methods (e.g. air transport). Finally, the assumed transport routes are a single trip from city of origin to Phoenix. Many commodities will make several trips prior to reaching their final point of consumption (e.g. for packaging, storage, processing, etc.). The overall impact of all of the assumptions is that the benefits are underestimated by a large amount.

Ancillary Benefits and Costs:

- Reduction in criteria and toxic air pollutants.
- Collaboration of local farm programs with other food programs provides nutritional education and increases the consumption of healthy foods for all Arizonans.
- Educate adults and children, about Arizona agriculture and agriculture's impact on their lives.
- Support for local agricultural jobs.

Feasibility Issues:

None identified. Much of this option involves a continuation and/or enhancement of existing programs.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

Table 5.
Cross Cutting Issues Technical Work Group
Summary List of Completed and Pending Policy Options

#	Policy Name	Status
CC-1	State Greenhouse Gas Goals	Completed
CC-2	State Greenhouse Gas Reporting	Completed
CC-3	State Greenhouse Gas Registry	Pending
CC-4	State Climate Action Education and Outreach	Completed
CC-5	State Climate Change Adaptation Strategy	Completed

CC-1 State Greenhouse Gas Goals

Policy Description:

Statewide GHG emissions reduction goals and or targets for future time periods.

Policy Design:

- **Goal levels:** The CCAG recommends that Arizona establish a statewide GHG reduction target to reach 2000 GHG levels by 2020, and 50 percent below 2000 GHG levels by 2040, coupled with a commitment to undertake early and aggressive GHG reduction actions by 2010 consistent with the reduction pathway required by goals in 2020 and 2040.
- **Timing:** 2010, 2020 and 2040.
- **Parties:** All sources of statewide GHG emissions combined.

Implementation Method(s):

Not considered for statewide goals per se, but the attainment of these goals is based upon full implementation of specific policy recommendations of the CCAG.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

All GHG's at levels consistent with long-term atmospheric stabilization.

Estimated GHG Savings and Costs per MTCO2e:

Determined by results of specific policy recommendations of the CCAG contained elsewhere in this report.

Data Sources, Methods and Assumptions:

The Arizona CCAG compared the framework and levels of goals in other US states that have set targets and timetables for initial consideration. Then, the CCAG reviewed the results of the full set of CCAG policy recommendations (pending at the time) and set a target consistent with full implementation of these measures in 2020, and extrapolation to 2040.

Key Uncertainties:

Future growth rate in emissions, particularly after 2020, as well as the timing and scope of implementation of the CCAG recommendations for specific policy options.

Ancillary Benefits and Costs:

In aggregate, reduction measures recommended by the CCAG to reach these goals provide significant cost savings, potential economic development, water resource savings, and energy savings.

Feasibility Issues:

Dependent upon the feasibility of individual policy option recommendations of the CCAG.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous

Barriers to Consensus:

None

CC-2 State Greenhouse Gas Reporting

Policy Description:

Measurement and public reporting of GHG emissions at a statewide, sector, or sub-sector level to support tracking and management of emissions. GHG reporting can help sources identify emission reduction opportunities and reduce potential risks associated with possible future GHG mandates by starting "up the learning curve." Tracking and reporting of GHG emissions will also help in the construction of periodic state GHG inventories. GHG reporting is likely to be a precursor for sources to participate in voluntary GHG reduction programs, opportunities for recognition, a GHG emission reduction registry, and to secure "baseline protection." Further, GHG reporting is an opportunity for the state to influence reporting practices throughout the region and nation, and to build consistency with other reporting programs. Subject to appropriately rigorous quantification, GHG reporting should not be constrained to particular sectors, sources, or approaches so as to encourage GHG mitigation activities from all quarters.

Policy Design:

Recommendations for key reporting program characteristics are noted in the accompanying "*GHG Reporting Design Options Matrix*." Elements include:

- Phasing in mandatory GHG reporting by sectors as rigorous, standardized quantification protocols, base data, and tools become available and responsible parties become clear; allowing for voluntary reporting before mandatory reporting applies; allowing the state itself to report emissions associated with its own activities and programs it implements.
- Applicability to all sources (e.g., combustion, processes, vehicles, etc.) but using common sense regarding de minimis emissions.
- Goal of reporting "organization-wide emissions within Arizona" but with greatest possible "granularity" to facilitate baseline protection, e.g., by "rolling up" total of "facility" & "field" emissions reports in a reporting database would provide organization totals in Arizona.
- Reporting annually on a calendar year basis for all six traditional GHGs and, to the extent possible, black carbon.
- Requiring reporting of direct emissions, phasing in reporting of emissions associated with purchased power and heat, and allowing voluntary reporting of other indirect emissions.

- Maximizing consistency with other state and federal reporting programs.
- Verifying emissions reports through self-certification and ADEQ spot-checks, adding third-party verification for registry purposes.
- Allowing for appropriate public transparency of reported emissions, and allowing voluntary project-based emissions reporting when properly quantified.

Goal levels: Not applicable.

Timing: ASAP, preferably by 2008.

Parties: Probably ADEQ.

Implementation Method(s):

None cited.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

All GHG's.

Estimated GHG Savings and Costs per MTCO2e:

Not applicable.

Data Sources, Methods and Assumptions:

Not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues, if applicable:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

CC-3 State Greenhouse Gas Registry

Policy Description:

Measurement and recording of GHG emissions reductions at a macro- or micro-scale level in a central repository with a "transaction ledger" capacity to support tracking, management, and "ownership" of emission reductions as well as to encourage GHG reductions, to enable potential recognition, baseline protection, and/or the crediting of actions by implementing programs and parties in relation to possible emissions reduction goals, and to provide a mechanism for regional, multi-state, and cross-border cooperation. Subject to appropriately rigorous quantification, GHG registration should not be constrained to particular sectors, sources, or approaches so as to encourage GHG mitigation activities from all quarters.

Policy Design:

Recommendations for key registry design characteristics build off the GHG Reporting policy option (CC-2) and are noted in the "*GHG Registry Design Options Matrix*" available at www.azclimatechange.us (under the Cross Cutting Issues Work Group link). Elements include:

- Geographic applicability at least at the statewide level and as broadly (i.e., regionally or nationally) as possible.
- Allowing sources to start as far back chronologically as good data exists, as affirmed by third-party verification, and allowing registration of project-based reductions or "offsets" that are equally rigorously quantified.
- Incorporating adequate safeguards to ensure that reductions aren't double-counted by multiple registry participants; providing appropriate transparency; and allowing the state to be a valid participant for reductions associated with its programs, direct activities, or efforts.
- Striving for maximum consistency with other state, regional, and/or national efforts; greatest flexibility as GHG mitigation approaches evolve; and providing guidance to assist participants.
- **Goal levels:** Not applicable.
- **Timing:** ASAP after GHG reporting is operating.
- **Parties:** Probably overseen by ADEQ; costs shared by participants benefiting from the registry.

Implementation Method(s):

Base the Arizona registry to extent possible on existing state registry programs, with augmentation and modification as needed to cover the full suite of potential state and regional programs and policies in the future.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

All GHG's.

Estimated GHG Savings and Costs per MTCO2e:

Not applicable.

Data Sources, Methods and Assumptions:

Not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues:

None cited.

Status of Group Approval:

Pending

Level of Group Support:

TBD

Barriers to Consensus:

TBD

CC-4 State Climate Action Education and Outreach

Policy Description:

Public education and outreach fosters a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens, and improves and expands their engagement in actions to reduce GHG emissions.

Policy Design:

As key starting points, the state should lead by example in its own education and outreach activities, and specific audiences should be identified for targeted education and outreach activities. Ultimately, public education and outreach will be the foundation for the long-term success of all the mitigation actions proposed by the CCAG as well as those, which may evolve in the future.

These audiences should include, but not be limited to:

- Policymakers (legislators, regulators, executive branch, agencies) – because implementation of climate actions hinges on policymakers' approval.
- Younger Generations – by integrating climate change into educational curricula, post-secondary degree programs, and professional licensing programs.
- Community Leaders & Community-Based Organizations (businesses, institutions, municipalities, service clubs, social & affinity groups, non-governmental organizations, etc.) – in order to recognize leadership; share success stories and role models; and expand climate involvement and participation within civic society.
- General Public – to increase awareness and engage citizens in climate actions in their personal and professional lives.

Implementation Method(s):

Outreach efforts should seek to integrate with and build upon existing outreach efforts involving climate change and related issues in the state.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

All GHG's/.

Estimated GHG Savings and Costs per MTCO2e:

Not applicable.

Data Sources, Methods and Assumptions (for quantified actions):

Not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

CC-5 State Climate Change Adaptation Strategy

Policy Description:

Because of the build-up in the atmosphere of greenhouse gases that already has occurred, Arizona will experience the effects of climate change for years to come, even if immediate action is taken to reduce future GHG emissions. As such, it is essential that the state develop a strategy to manage the projected impacts of ongoing climate change.

Policy Design:

While taking action to reduce greenhouse gas (GHG) emissions in Arizona, the Governor also should explore, develop, and implement a state climate change adaptation strategy that identifies the potential near-term and short-term impacts of climate change scenarios affecting the State, outlines steps that should be taken to respond to those impacts, and coordinates these steps with response plans and efforts that are underway or may be contemplated at other agencies or organizations or through other initiatives. These impacts include the concerns outlined by the Governor in her February 2005 Executive Order (e.g., prolonged drought, severe forest fires, warmer temperatures, increased snowmelt, and reduced snow pack) as well as other serious issues, including risks to public health.

A comprehensive state climate change adaptation strategy should include time- and program- based goals, characterization of the potential risks and costs of inaction, and the potential costs, benefits, and co-benefits associated with specific policy and program actions and time periods.

The Governor should consider appointing a task force or advisory group to develop recommendations for the state adaptation strategy. Moreover, the Governor should direct state agencies and other appropriate institutions to identify and characterize potential current and future risks in Arizona to human, natural and economic systems, including potential risks to water resources, temperature sensitive populations and systems, energy systems, transportation systems, vital infrastructure and public facilities, and natural lands (such as forests, rangelands, and farmland).

Adaptation measures that also help mitigate GHG emissions should be given priority in the state climate change adaptation strategy, particularly water use conservation and efficiency, forest and agriculture conservation and management, energy production and use, facility siting and management, infrastructure development, and efficient transportation and land use systems. These actions should be linked to implementation of other specific recommendations of this Climate Change Advisory Group to the greatest extent possible.

Finally, the state climate change adaptation strategy should be reviewed and updated on a regular basis.

Implementation Method(s):

None cited.

Related Policies/Programs in Place:

None cited.

Types(s) of GHG Benefit(s):

All GHG's.

Estimated GHG Savings and Costs per MTCO2e:

Not applicable.

Data Sources, Methods and Assumptions:

Not applicable.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.